ATLAS OF MALE GENITOURETHRAL SURGERY

THE ILLUSTRATED GUIDE

Edited by

Asif Muneer | Manit Arya | Gerald H. Jordan

WILEY Blackwell

Atlas of Male Genitourethral Surgery

The Illustrated Guide

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Preface

Asif Muneer, Manit Arya and I are pleased to offer you this Atlas, which illustrates many of the procedures of genital reconstruction that are not covered elsewhere in other atlases. The text is illustrated with intraoperative photographs, showing the surgical procedures in a step-by-step fashion.

While many of the anomalies illustrated are often the subject of humor, the penis is prone to a host of disorders that often are the result of disease and/or trauma. Additionally, congenital penile anomalies are surprisingly common. Erectile dysfunction is a subject that has recently been covered in great detail, now that there are many options for medical as well as surgical management. Cancer of the penis, penile augmentation, and other challenges are all now routinely addressed in centers of excellence worldwide. New surgical techniques for correcting these problems have recently been advanced.

Each chapter begins with an introduction to the condition and its challenges, continues with a step-by step guide to the procedures applicable for that condition, and ends with surgical tips for improved techniques and outcomes. Experts have been asked to illustrate "their way of handling things." Their way may become your way, or parts of their way may influence your current management process. The Atlas is designed for the already trained surgeon who is interested in examining the potential of expanding their practice, or just looking for other ways of undertaking genitourethral surgery.

Gerry Jordan

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We would like to thank all of our contributors and the publishing team for their valuable time and effort in helping us to compile this Atlas.

Finally, to all our family and friends – thank you for your patience.

1

Surgical Anatomy of the Male External Genitalia

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Introduction

As with all surgical procedures, an understanding of the anatomy not only allows planning for reconstructive procedures, but also allows the genitourethral surgeon to revert to basic anatomic principles when faced with difficult cases, complications or revision surgery.

The perineum

The male external genital organs comprise the penis, scrotum and scrotal contents. Any detailed description of the anatomy of the external genitalia, whether in the male or in the female, would be incomplete without a preliminary consideration of the anatomy of the perineum. The perineum refers to the lowest part of the trunk. It lies immediately below the pelvic floor (levator ani) and is flanked by the inner aspect of the proximal ends of the thighs and also by the inferior parts of the buttocks. When the thighs and buttocks are parted, the perineum may be pictured as lying within the osseo-ligamentous framework of the inferior pelvic aperture. This framework has a diamond-shaped outline (Figure 1.1): the four angles of the diamond being the sub-pubic angle anteriorly (long arrow), the coccyx posteriorly (short arrow) and the right and left ischial tuberosities on either side. The four sides of the diamond are the right and left ischiopubic rami anterolaterally, and the inferior edges of the right and left sacro-tuberous ligaments posterolaterally (Figure 1.1).

A transverse line drawn between the anterior ends of the right and left ischial tuberosities is seen to divide the perineum into two triangular divisions. The anterior division is the smaller of the two and is known as the urogenital triangle (urogenital region) of the perineum, while the larger posterior division is the anal triangle (anal region) of the perineum. The anal triangle of the perineum is similar in the two sexes, and contains the centrally located anal canal flanked by the right and left ischioanal (ischiorectal) fossae.

Stretching across the width of the urogenital triangle of the perineum from the inner surface of one ischiopubic ramus to the other is a distinct fascial layer termed the perineal membrane. The perineal membrane is quadrangular in outline and is confined to the urogenital triangle of the perineum (Figure 1.2).

It serves to demarcate the two principal subdivisions of the urogenital triangle: the deep perineal pouch and superficial perineal pouch. The former lies deep to (i.e. above) the perineal membrane and contains the membranous urethra, external urethral sphincter (the voluntary, striated muscle sphincter) and the deep transverse perinei muscles. Additionally, in the male, the bulbo-urethral glands (Cowper's glands) are situated in the deep perineal pouch, posterolateral to the membranous urethra. The ducts of the bulbo-urethral glands, however, penetrate the perineal membrane and open into the bulbous urethra in the superficial perineal pouch.

The superficial perineal pouch lies superficial to (i.e. below) the perineal membrane. This demarcation into the superficial and deep perineal pouches is more apparent in the male subject (owing to the perineal membrane being a more readily demonstrable entity in the male). The male external genitalia are situated entirely in the superficial perineal pouch. The gap between the anterior edge of the perineal membrane and the inferior border

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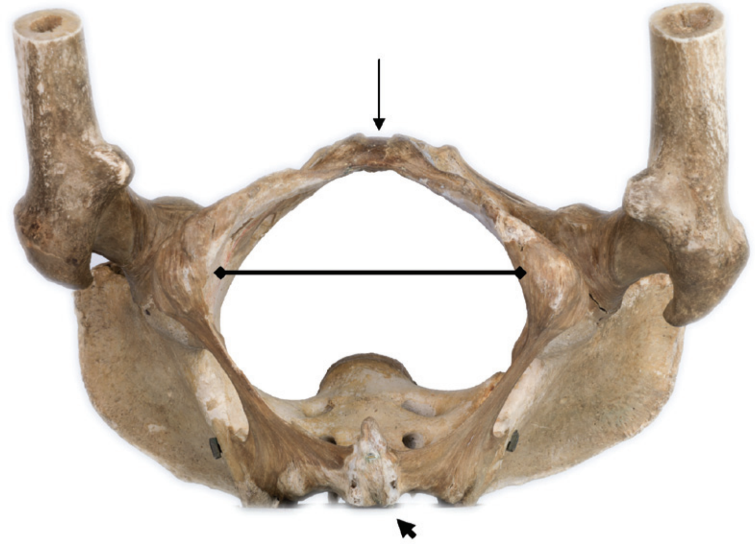

Figure 1.1 Pelvic outlet showing the urogenital and anal regions. The dividing line separates the outlet into a triangular anterior urogenital region containing the external genitalia. The anal region contains the anal canal and ischioanal fossae.

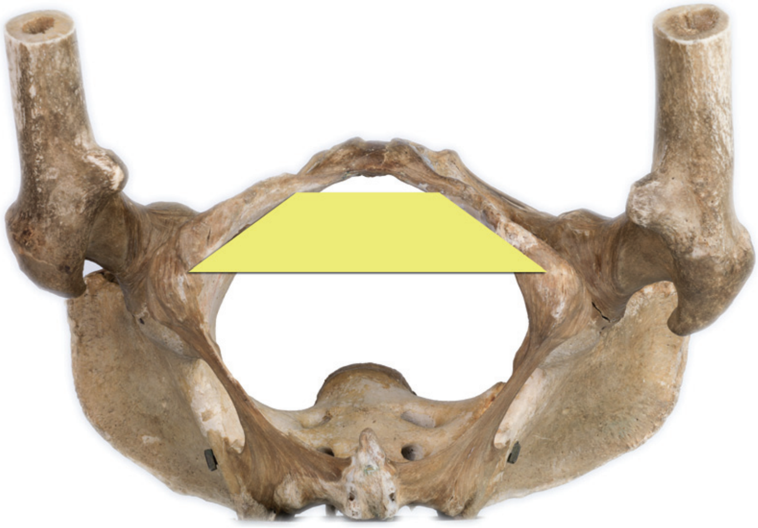

Figure 1.2 Outline of the quadrangular perineal membrane confined to the urogenital triangle of the perineum.

of the pubic symphysis transmits the deep dorsal vein of penis (or the dorsal vein of clitoris in the female).

Terminology in relation to the fascial layers in the urogenital region of the perineum

The membranous layer of superficial fascia in the anterior abdominal wall (Scarpa's fascia) is continued into the urogenital triangle of the perineum in both sexes as the superficial perineal fascia. In the male, this superficial perineal fascial layer is prolonged into the scrotum as the dartos fascia (tunica dartos) and contains smooth muscle on its surface. The prolongation of the superficial perineal fascia over the penile shaft is termed the superficial penile fascia, while the remainder of the superficial perineal fascia is attached to the posterior edge of the perineal membrane and to the outer margins of the everted ischiopubic rami and is termed Colles' fascia. The superficial perineal pouch is the space between the perineal membrane and the overlying superficial perineal fascia. In the male it contains the root of the penis and the associated muscles. As the superficial perineal fascia is continued into the scrotum and around the penile shaft, the superficial perineal pouch may be said to include also the scrotal contents and the penile shaft.

Deep to the superficial penile fascia is a distinct fascial layer which encircles the erectile columns (i.e. the fused corpora cavernosa and corpus spongiosum) in the penile shaft. This is the deep fascia of the penis, known also as Buck's fascia. Traced proximally, Buck's fascia is seen to be continuous with the deep fascia that covers the muscles that overlie the root of the penis, termed Gallaudet's fascia.

The principal blood supply to the perineum is derived from the right and left deep internal pudendal arteries, each being a terminal branch of the corresponding internal iliac artery's anterior division. Venous drainage is to the ipsilateral internal pudendal vein which in turn drains to the internal iliac vein. The motor innervation of all the voluntary muscles in the perineum as well as the cutaneous innervation of much of the perineum is a function of the right and left pudendal nerves. The pudendal nerve is a branch of the sacral plexus and has a root value of S2, S3 and S4.

The internal pudendal artery and pudendal nerve may therefore be spoken of as the artery and nerve of the perineum, respectively. Both these structures originate in the pelvic cavity (i.e. above the pelvic floor). They leave the pelvic cavity through the ipsilateral greater sciatic foramen (a large opening in the posterolateral aspect of the pelvic wall). Turning sharply around the tip of the ischial spine, the nerve, artery (and companion vein) run forwards *below* the pelvic floor to enter a fascial sleeve (the pudendal canal) within the obturator fascia in the lateral wall of the perineum.

The scrotum and scrotal contents

The scrotum is a pendulous, cutaneous sac that contains the testes, epididymes and the lower ends of the spermatic cords with their associated coverings. The scrotum is, in effect, an extension of skin and subcutaneous tissue of the anterior abdominal wall into the urogenital part of the perineum. It is suspended below the pubic arch and lies postero-inferior to the root of the penis.

The skin of the scrotum is hair-bearing and relatively thin and is generally more pigmented than the adjacent skin of the thigh and pubic region. It contains numerous sweat glands and sebaceous glands. The scrotum is devoid of subcutaneous fat; a feature that is thought to play a significant part in maintaining the intrascrotal temperature somewhat below the core temperature which is required for normal spermatogenesis. The rugosity of the scrotal skin is due to the contraction of the underlying dartos muscle.

A median septum within the scrotum divides the scrotum into right and left compartments. The septum is essentially an infolding of the dartos layer of the scrotum. The left hemiscrotum typically hangs somewhat lower than the right. The position of the intrascrotal septum is indicated on the surface by a narrow, midline ridge termed the median scrotal raphe. This raphe is continuous anteriorly with the penile raphe (on the undersurface of the penis), and posteriorly with the perineal raphe (which extends backwards almost to the anterior margin of the anal verge). Immediately deep to the dartos fascia and within each hemiscrotum are the three fascial coverings of the spermatic cord, concentrically arranged and closely applied to each other. From outside in they are the external spermatic fascia, cremasteric fascia and internal spermatic fascia. Within the latter is the tunica vaginalis testis, a thin-walled, double-layered serous membrane containing a film of fluid between the two layers. The tunica is applied to the front and sides of the testis and epididymis.

The testis is an ovoid, firm organ with its long axis vertically orientated. It is enveloped in a thick, pale fibrous covering termed the tunica albuginea. The tunica sends multiple septa into the testicular substance, breaking up the latter into numerous lobules each containing two to three highly convoluted seminiferous tubules. The seminiferous tubules from the various lobules converge posteriorly upon the rete testis, a plexiform structure. From the rete testis 12–15 ducts (vasa efferentia) penetrate the tunica albuginea and empty into the head of the epididymis. The epididymis is a firm structure but softer to the feel than the testis. It serves as a receptacle for the storage and maturation of spermatozoa. The epididymis is applied to the posterolateral aspect of the testis, and appreciation of this topographic relationship is of importance in the clinical diagnosis of testicular and epididymal conditions. The testis is supplied by the testicular artery, a direct branch of the abdominal aorta. Running down the posterior abdominal wall, the testicular artery enters the inguinal canal through the deep inguinal ring and emerges at the superficial inguinal ring to enter the spermatic cord along with the other contents of the spermatic cord (testicular lymphatics, vas deferens, artery to the vas, pampiniform plexus/testicular veins, sympathetic nerve fibers, cremasteric artery, genital branch of the genitofemoral nerve).

The large, upper end of the epididymis is the head (or globus major) and the narrow, lower pole is the tail (or globus minor). The intervening part is termed the body of the epididymis. Apart from the vasa efferentia, which run from the rete testis to the head of the epididymis, there is no direct physical connection between the testis and epididymis. The narrow slit-like space between the two is termed the sinus of the epididymis. The blood supply of the epididymis is from the testicular artery.

The vas deferens is the direct continuation of the tail of the epididymis. It runs upwards medial to the epididymis and so enters the spermatic cord. The blood supply of the vas is from the artery to the vas, a branch of the inferior vesical artery.

Blood supply, lymphatic drainage and cutaneous innervation of the scrotum

The anterior surface of the scrotal wall derives its blood supply from the superficial and deep external pudendal arteries bilaterally. Both arteries are early branches of the (common) femoral artery. They arise from the latter just below the level of the inguinal ligament, run medially and supply the anterior aspect of the scrotum of their side. The posterior aspect of the scrotal wall obtains its blood supply from the posterior scrotal arteries which are branches of the perineal artery, in turn a branch of the internal pudendal artery. Arteries in the anterior scrotal wall tend to run transversely, while those supplying the posterior aspect of the scrotal wall run longitudinally. Flaps can therefore be harvested from the well-vascularized scrotal skin and transferred to the urethra, penile shaft and the inguinal region.

Venous drainage from the wall of the scrotum is predominantly via the superficial and deep external pudendal veins, on each side, to the ipsilateral great saphenous vein. However, the midline of the scrotum drains medially and not laterally which is an important consideration when faced with conditions such as scrotal lymphedema.

Lymphatic drainage from the scrotal wall is to the ipsilateral superficial inguinal lymph nodes. Lymphatic drainage of the scrotal contents, however, is different. Lymphatics from the testis run within the spermatic cord and eventually drain to the para-aortic lymph nodes near the origin of the gonadal arteries (at approximately L2 vertebral level). Lymphatics from the epididymis drain principally to the ipsilateral internal iliac lymph nodes.

Cutaneous innervation of the anterior aspect of the scrotum is by the right and left ilioinguinal nerves (L1). Each nerve innervates the anterior third of the corresponding hemiscrotum. The genital branch of the genitofemoral nerve makes a minor contribution. The posterior scrotal skin is innervated by the scrotal branches of the perineal nerve (branch of the pudendal nerve) with an additional contribution from the perineal branch of the posterior femoral cutaneous nerve. The posterior scrotal skin corresponds to the S3 dermatome.

The dartos muscle in the scrotal wall is innervated by sympathetic fibers conveyed by the genital branch of the genitofemoral nerve.

The penis

The penis is the male copulatory organ and conveys the entire length of the spongiose urethra (the spongiose urethra, in turn, being divided into the bulbar, pendulous or penile and glanular segments). The glanular portion of the urethra has recently been also divided into two portions, the fossa navicularis and the meatus. The non-tumescent penis hangs below the pubic symphysis and in front of the scrotum, overlapping the median scrotal raphe. The dorsal surface of the penis is the surface that faces the anterior abdominal wall when the penis is erect. Thus, when the penis is flaccid, the dorsal surface faces anteriorly and the ventral surface faces posteriorly.

The penis consists of three parts: the root (radix), the shaft (body or corpus) and glans. The root of the penis is the proximal end of the organ, and is firmly attached to the inferior surface of the perineal membrane and to the inner aspects of the ischiopubic rami. It is made up of three somewhat elongated masses of erectile tissue: two crura (one on either side) and a centrally situated bulb of the penis (Figure 1.3).

Each crus is attached to the inner surface of the ischiopubic ramus of its side immediately in front of the ischial tuberosity, and in part also to the inferior surface of the adjacent perineal membrane, while the bulb is attached, in its entirety, to the inferior surface of the perineal membrane. Each crus is covered by the corresponding ischiocavernosus muscle while the bulb is covered by the bulbospongiosus muscle. The correct nomenclature for this is the midline fusion of the ischiocavernosus muscle. Distally, the three elements of the

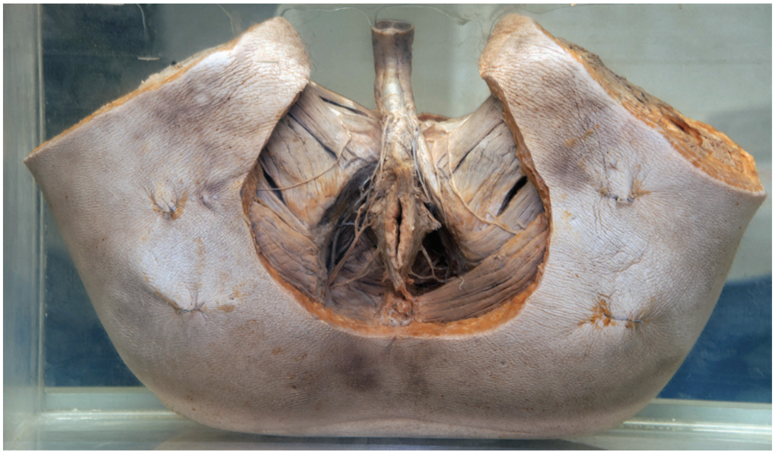

Figure 1.3 Cadaveric dissection demonstrating the origins of the root of the penis and the vascular supply.

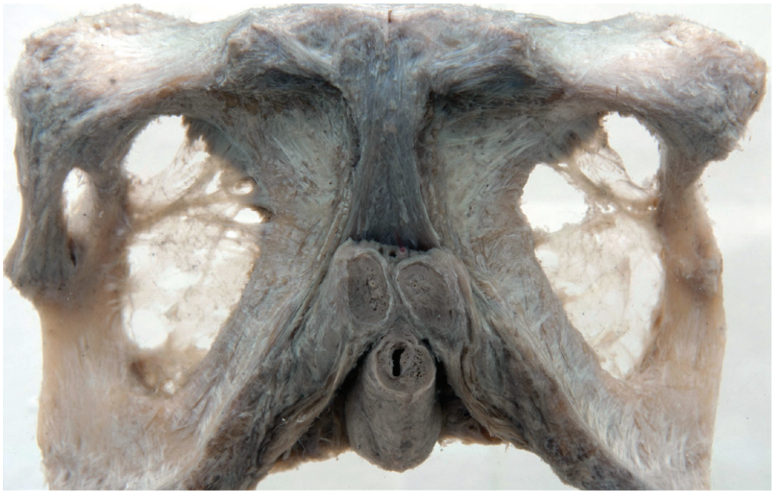

Figure 1.4 Cadaveric dissection showing the three components of the root of the penis as they continue to form the penile shaft.

penile root (the two crura and the bulb) converge towards each other at the proximal end of the penile shaft, whence the two crura are prolonged within the penile shaft as the corpora cavernosa, and the bulb is continued as the corpus spongiosum. The muscles (ischiocavernosi and bulbospongiosus) are not prolonged into the penile shaft (Figure 1.4).

The shaft of the penis is made up of three columns of erectile tissue: the right and left corpora cavernosa, and the median corpus spongiosum. The two corpora cavernosa lying side by side are situated dorsal to the midline corpus spongiosum, the latter lying in a longitudinal groove between the apposed corpora cavernosa. The crura, bulb and corresponding corpora are each made up of spongy connective tissue comprising an interconnected network of highly vascular sinusoids.

The corpus spongiosum and the two corpora cavernosa are each contained within a dense fibrous sheath termed the tunica albuginea. The fibrous sheaths of the two corpora cavernosa are fused with each other to form the median septum of the penis and on the ventral aspect these sheaths are fused with that of the corpus spongiosum. These sheaths are collectively enveloped by the deep penile fascia (Buck's fascia). The median septum is incomplete in places, thereby allowing the cavernosal erectile tissue of the two sides to communicate with each other. There is a varying relationship of the corpus cavernosum to the corpus spongiosum, whereby it is dorsally displaced

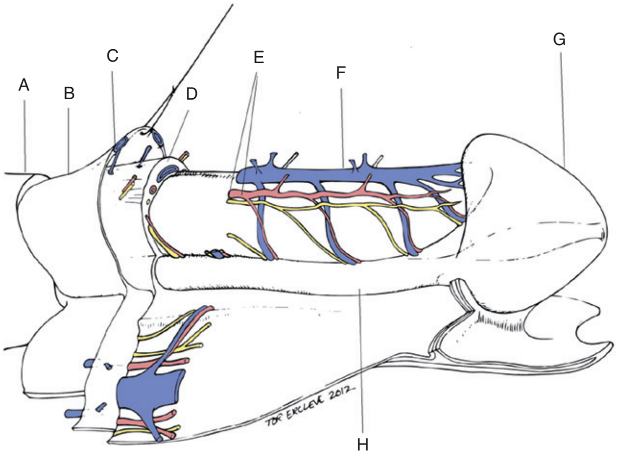

Figure 1.5 The skin and fascial layers of the penis and the location of the neurovascular bundle. A, skin; B, loose areolar tissue and dartos layer; C, superficial dorsal vein; D, Buck's fascia; E, deep dorsal artery and nerve; F, deep dorsal vein; G, glans; H, corpus spongiosum. (Source: Tor Ercleve. Reproduced with permission of Tor Ercleve.)

in the proximal aspect, centrally placed in the pendulous part, and ventrally displaced in relationship to the erectile tissue of the glans (Figure 1.5).

The glans penis is the somewhat conical (acorn-like) distal end of the penis. It is in effect a continuation of the corpus spongiosum. It is demarcated from the penile shaft by a shallow, obliquely orientated circumferential groove termed the neck of the penis. The base of the glans has a rounded edge which partially overhangs the neck of the penis, and is termed the corona of the glans (corona glandis).

The penile skin is thin, dark, hairless (except at the very proximal end of the shaft) and fairly freely mobile. From the neck of the penis, the skin extends distally as the prepuce or foreskin, a circumferential, double-layered, mobile retractable hood over the glans. The extent to which the prepuce covers the glans varies between individuals. The preputial frenulum is a median fold of skin that passes from the inner layer of the prepuce to the ventral surface of the glans adjacent to the external urethral orifice.

Blood supply, lymphatic drainage and innervation of the penis

The penis derives its arterial supply exclusively from the right and left deep internal pudendal arteries, each giving rise to the common penile artery which then divides into an artery to the bulb, a deep artery of the penis (referred to in urological literature as the cavernosal artery) and a dorsal artery of the penis (Figure 1.6).

The artery to the bulb supplies the bulb, corpus spongiosum, glans penis and the entire spongiose urethra. The deep artery supplies the ipsilateral crus of the penis and the corresponding corpus cavernosum. It enters the crus and breaks up into numerous helicine branches which supply the erectile tissue of the corpus. The dorsal artery supplies the penile skin, the dartos layer and the deeper fascial layers. The deep artery of the penis and the dorsal artery of the penis arborize distally in the erectile tissue of the glans penis and therefore provide retrograde blood flow into the corpus spongiosum.

The venous drainage of the penile skin and superficial structures is to the superficial external pudendal veins bilaterally, and thence to the right and left great saphenous veins. Venous drainage of the deeper structures including the erectile tissue is to the deep dorsal vein of the penis. This in turn runs posteriorly under the pubic symphysis to drain to the periprostatic venous plexus (of Santorini).

The lymphatic drainage of the penis is as follows. Lymph from the penile skin drains into the superficial inguinal lymph nodes bilaterally. Lymph from the glans penis and from the distal parts of the corpus spongiosum and corpora cavernosa drains into the deep inguinal lymph nodes, and thence to the external iliac lymph nodes. Lymph from the proximal parts of the erectile tissue drains into the internal iliac lymph nodes.

The cutaneous innervation of the penis is from the right and left dorsal nerves of the penis which supply the

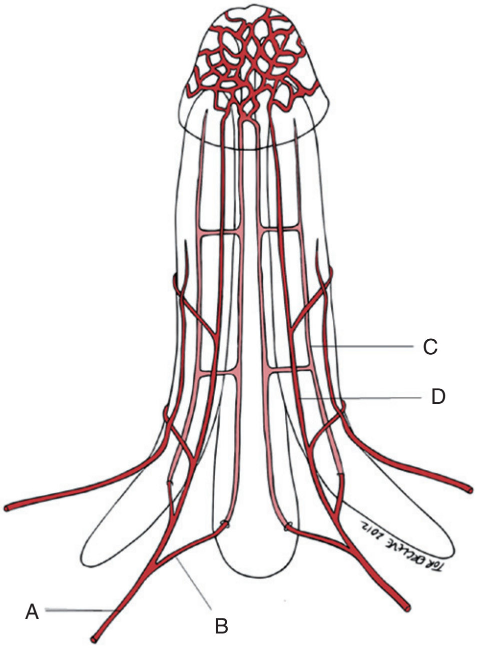

Figure 1.6 Arterial supply to the penis. A, common penile artery; B, artery to bulb; C, deep artery of the penis (cavernosal artery); D, dorsal artery of penis. (Source: Tor Ercleve. Reproduced with permission of Tor Ercleve.)

dorsal penile skin, the glans penis and glanular urethra. Each dorsal nerve of the penis is a terminal branch of the corresponding pudendal nerve. The ventral skin of the penis is innervated by the right and left posterior scrotal nerves, in turn, branches of the corresponding perineal nerves. The dermatome represented by the penile skin is S2.

The muscles of the penile root – the bulbospongiosus and the ischiocavernosi – are striated muscles and derive their motor innervation from the right and left perineal nerves, each being a terminal branch of the corresponding pudendal nerve.

The erectile tissue comprising the corpora cavernosa and corpus spongiosum is innervated by the parasympathetic fibers in the pelvic splanchnic nerves (S2, S3 and S4).

Ligamentous support of the penis

Two so-called ligaments are attached to the dorsal aspect of the penis at the junction of the root and shaft of the penis and provide suspensory support. The more deeply placed of these is termed the suspensory (or triangular) ligament. From its attachment to the anterior aspect of the pubic symphysis it runs downwards to blend with Buck's fascia on either side of the proximal end of the penile shaft. The other ligament is termed the fundiform ligament. Arising from the lower end of the linea alba just above the pubic symphysis, it runs inferiorly and splits into left and right laminae. These laminae run one on either side of the proximal penile shaft and meet on the ventral (inferior) aspect of the penis and pass into the scrotal septum.

Injury to either of these ligamentous structures can occur in trauma to the anterior part of the pelvic ring with a resultant ventral angulation of the penile shaft when the penis is erect.

2

Basic Perioperative Considerations for Genitourethral Surgery

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Introduction

A knowledge of the surgical anatomy and the surgical steps to complete a surgical procedure has to be preceded by a strategy in which the appropriate operation is selected for the correct patient. This approach will ensure that the optimal outcome is achieved. Importantly, this approach requires patient counseling with regard to the risks and expectations related to the surgery, as well as meticulous preoperative patient preparation and postoperative care.

Preoperative preparation

Once the decision has been made to perform a specific surgical procedure, patients should be assessed in a pre-assessment clinic to ensure that any significant co-morbidities are optimized in coordination with the anesthetic team. This also ensures that patients are aware of changes to their medication preoperatively, including cessation or adjustment of oral anticoagulant treatment and diabetic medications. Cardiac and pulmonary status is also assessed and this can be further evaluated using cardiopulmonary exercise (CPEX) testing. Diabetic control should be optimized, particularly for those patients undergoing prosthetic surgery.

Prior to genitourethral surgery, urinary tract infections should be diagnosed and treated. A mid stream sample of urine (MSSU) 7 days prior to surgery is cultured and if necessary the patient treated with appropriate antibiotics. The urine should be retested prior to surgery in order to ensure that the urine is sterile.

At this stage patients also have the opportunity to understand the procedure and the postoperative recovery. It is also a further opportunity to review the indications for surgery.

Preoperative imaging

Imaging techniques are integral to the diagnosis and planning of genitourethral procedures. Not only is this for diagnostic purposes, but also to aid the planning of surgery. For site-specific surgery (e.g. radical inguinal orchidectomy) the diagnostic ultrasound imaging (Figure 2.1) should be available to the surgeon in theatre prior to undertaking the surgical procedure. This is then correlated with the clinical evaluation and the preoperative marking on the patient. Until this is checked and agreed, the operation should not commence.

For urethral surgery, preoperative urethrograms are routinely performed to visualize the site and length of the stricture (Figure 2.2). It may be the surgeon's preference to perform these in his or her own practice. A retrograde urethrogram can be performed by inserting a 12-F catheter into the fossa navicularis and inflating the balloon with 2 mL of water. Under fluoroscopic guidance

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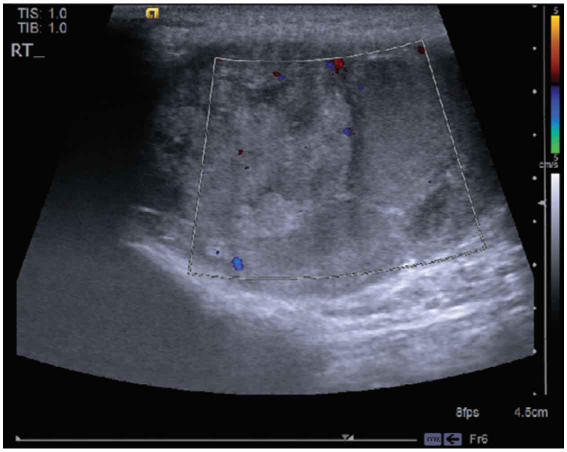

Figure 2.1 Ultrasound of scrotum showing a tumor within the testicle.

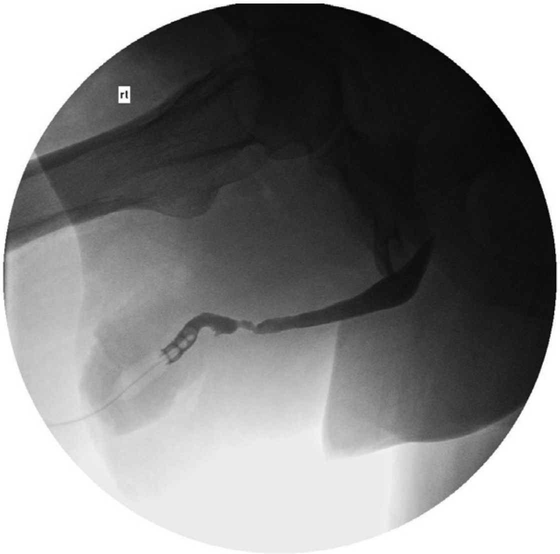

Figure 2.2 Preoperative ascending urethrogram showing narrowing in the anterior urethra.

20–30 mL of water-soluble contrast is slowly injected into the urethra.

Pericatheter urethrograms may be performed following urethroplasty surgery or repair of urethral injuries. A fine-bore tube is inserted alongside the catheter and water-soluble contrast is injected to ensure that there is no leak from the site of the repair.

Perioperative checklist

It is now common practice to undertake a core set of safety checks: the World Health Organization (WHO) Surgical Safety Checklist. The WHO checklist allows safe anesthetic practice, correct site surgery, avoids surgical site infections and improves communication, prior to, during surgery and also in the postoperative period.

Patient preparation in theatre

Genitourethral surgery will invariably involve operating on hair-bearing skin. Therefore careful epilation of the skin is required on the operating table prior to preparing the skin with antiseptic. Procedures that involve the use of prostheses should have a strict protocol in order to reduce the risk of infection. These include the use of Hibiscrub (chlorhexidine) showers for 24–48 hours preoperatively combined with Naseptin cream. Any focus of infection in the region of the operative site should be treated before undertaking prosthetic surgery. A 10-minute scrub using an iodine-based preparation should be performed and the number of theatre personnel is minimized, with restrictions on the number of individuals entering or leaving the theatre setting. As well as administering parenteral antibiotics, further antibiotic solutions can be used for irrigation. A “no touch” technique for handling the prosthesis will also reduce the risk of infection.

Patients undergoing penile surgery due to curvature or penile augmentation should have their stretched penile length measured and documented before and after the procedure. This can be measured from the symphysis pubis to either the tip of the glans penis or the coronal sulcus using a rigid ruler.

Patient warming

The value of warming in medical practice has been known for thousands of years in treating wounds and for pain relief. Recent literature has shown that patient warming reduces blood loss and surgical infections. Patient warming can be achieved by conduction, convection or radiation. Passive warming by insulation alone is not useful in preventing or treating hypothermia.

Systemic active warming is proved to be a gold standard for major surgeries. Use of heated flexible carbon polymer sheet (Inditherm Medical Products, UK) in the operating table provides a uniform heating area and reliable patient warming.

Deep venous thrombosis prophylaxis

The guidelines for the prevention of thromboembolic disease in surgical patients are formulated by the Thromboembolic Risk Factor Consensus Group (THRIFT), originally published in 1992. They define high, moderate and low risk surgery, and the recommendations for prophylaxis are based on the risks of deep venous thrombosis (DVT) and fatal pulmonary embolism (PE) in each group.

High risk group

The risk of DVT is 40–80% and PE is 1–10%. These patients should receive high-dose prophylaxis of low molecular weight heparin (LMWH), compressive stockings (unless contraindicated) and pneumatic calf compression used intraoperatively. The patients in this category are:

- Long bone fracture or major orthopedic surgery;
- Major surgery lasting >2 hours;
- Past history of DVT and/or PE;
- Acute lower limb paralysis; and
- Major pelvic or abdominal cancer surgery.

Moderate risk group

The risk of DVT is 10–40% and PE is 0.1–1%. All of the following patients should receive low dose LMWH and compressive stockings:

- Obesity, age >40 years;
- Malignancy, infection, polycythemia;
- Heart failure or myocardial infarction;
- Major trauma (other than pelvis or lower limbs) or burns; and
- Minor surgery, trauma or illness in patients with previous DVT and/or PE.

Low risk group

The risk of DVT is less than 10% and PE is <0.1%. These patients should be mobilized early postoperatively, with or without the need for compressive stockings:

- Minor surgery <30 minutes at any age with no other risk factors;
- Minor surgery >30 minutes at age <40 years with no other risk factors; and
- Minor trauma or illness.

Surgical sutures

The ideal suture is one that maintains its tensile strength until its purpose is served, elicits minimal tissue reaction, does not encourage bacterial colonization and is not allergenic, carcinogenic or electrolytic. Also, the surgical suture selected should handle well, knot securely and be inexpensive. Surgical sutures can be classified as absorbable or nonabsorbable, braided or monofilament, and natural or synthetic. The most commonly used sutures are listed below.

Polyglactin (Vicryl^{TM})

This is a synthetic, braided and absorbable suture, which elicits little tissue reaction and is usually absorbed between 56 and 70 days. It provides wound support for 30 days.

Vicryl rapide^{TM}

This is similar to Vicryl^{TM} but it degrades more rapidly and only provides wound support for approximately 10 days.

Polydioxanone sutures (PDS^{TM})

This is a synthetic, monofilament and absorbable suture. It will hydrolyze slowly (180 days) with good tensile strength for up to 56 days. The tensile strength is ideal for penile straightening procedures that are subjected to tissue expansion during the postoperative erections.

Silk

This is a natural, braided and nonabsorbable suture. As it induces a marked tissue reaction it is used less commonly today but it provides good tissue support for 1 year.

Polypropylene (Prolene^{TM})

This is a synthetic, monofilament and nonabsorbable suture. It is the suture of choice for vascular anastomosis but the significant memory makes it difficult to handle. Inadvertent crushing of the suture will lose 90% of the suture tensile strength.

Nylon (Ethilon^{TM})

This is a synthetic, monofilament and nonabsorbable suture. It has similar characteristics to Prolene^{TM} but with less significant memory. This is ideal for microvascular work and microsurgical procedures for infertility.

Suture properties

Sutures vary in their strength and time taken to dissolve (Table 2.1). The suture packet will provide

Table 2.1 Selection of commonly used sutures showing strength and approximate time to dissolve

Suture name	Suture material	50% strength retention (approx days)	100% suture dissolvable time (approx days)
Vicryl rapide™	Braided polyglactin	5	42
Monocryl™	Monofilament poliglecaprone	7	90
Vicryl™	Braided polyglactin	21	56
PDS™ II	Monofilament polydiaxanone	28	180

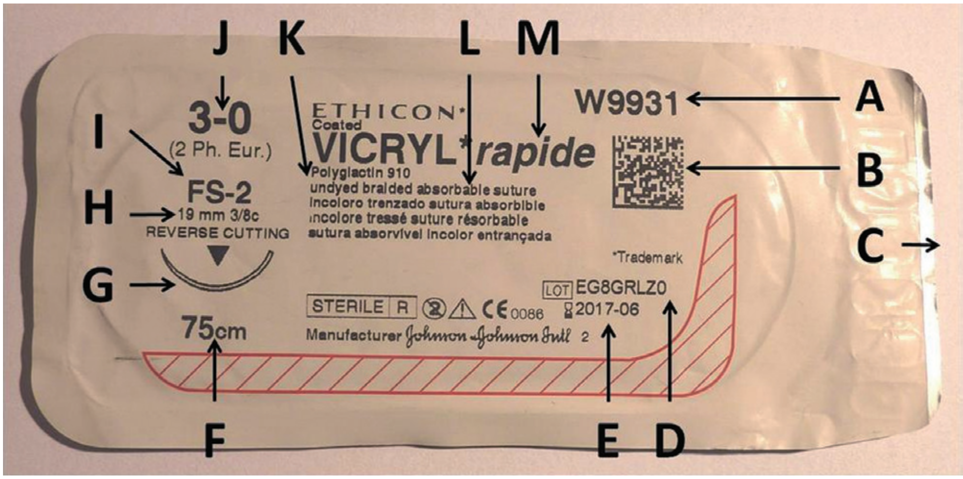
J
K
L
M
3-0
(2 Ph. Eur.)
ETHICON
Coated
VICRYL* rapide
W9931
A
B
C
I
FS-2
H
19 mm 3/8c
REVERSE CUTTING
Polyglactin 910
undyed braided absorbable suture
incoloro trenzado sutura absorbible
incolore tressé suture résorbable
sutura absorvível incolor entrançada
*Trademark
G
LOT EG8GRLZ0
STERILE R
CE 0086
2017-06
75cm
Manufacturer Johnson & Johnson Intl 2
F
E
D

Figure 2.3 The information available on a typical suture packet. A, product code in catalog; B, quick response code; C, sterile opening strip; D, lot number; E, expiry date; F, suture length; G, needle type; H, needle length and shape (3/8 of a circle); I, needle number in catalog; J, thread size; K, suture material; L, suture properties; M, suture name.

information regarding the suture and needle properties (Figure 2.3).

Closure of dead space and the use of drains

The inherent elasticity for the penile and scrotal skin to stretch makes it susceptible to the accumulation of blood and serous fluid. As this may result in infection it is important that all dead spaces are closed in layers when suturing to avoid the accumulation of blood and serous fluid.

Drains will avoid the accumulation of urine, blood and lymph and prevent secondary infection or abscess formation. Suction drains, tube drains or corrugated drains can be used, depending on the site of the surgery or procedure performed. The drain should be brought out through a separate incision from the main wound to prevent infection of the main wound and secured with nonabsorbable sutures.

Surgical wound dressing

It is noteworthy to mention that not all surgical wounds need dressings. The ideal wound dressing should have the following characteristics:

- Provide mechanical and bacterial protection;
- Allow gaseous and fluid exchange;
- Remain nonadherent to the wound;
- Safe in use – nontoxic, nonsensitizing and nonallergic (both to the patient and medical personnel);
- Highly absorbable (for exuding wounds);
- Absorb wound odour and be sterile;
- Easy to use (can be applied by medical personnel or the patient) and need less frequent changing; and
- Cost effective and available in different forms and sizes.

There are numerous forms of surgical wound dressings. Generally, they can be classified into the following categories.

Hydrocolloids (e.g. Granuflex)

These are a matrix of cellulose and other gel-forming agents. They are occlusive dressings and should be avoided if infection, particularly with anaerobic organisms, is possible.

Alginates (e.g. Kaltostat)

These calcium and sodium salts of alginic acid are highly absorbent and used in medium to heavily exudating wounds. They form a gel when in contact with wound exudates.

Foam dressings (e.g. Lyofoam)

These are useful for moderately exudating wounds as they prevent release of exudates to wound surfaces and promote sloughing of wounds by maintaining a moist environment.

Hydrogels (e.g. Intrasite Gel)

The high water content of these dressings creates a moist wound surface. This is not appropriate for heavily exudating wounds.

Debriding agents (e.g. streptokinase)

These remove eschar and necrotic tissue but they require frequent changes until the wound heals.

Negative pressure topical dressings

These apply negative pressure via a foam dressing, remove wound exudates and reduce extravascular and interstitial fluid, and improve the blood supply during the inflammatory phase.

Vacuum-assisted closure dressings

Vacuum-assisted closure (VAC) dressings are used in cases where significant tissue loss occurs (e.g. Fournier's gangrene and wound dehiscence following inguinal lymphadenectomy). VAC dressings use a sponge with a vacuum suction underneath an occlusive dressing. This facilitates the removal of exudates from the wound into the sponge. VAC dressings reduce local edema and thereby increase perfusion, resulting in early wound closure.

Modulation of erectile function before and after penile surgery

Penile surgery that involves the use of skin grafts requires graft immobilization following the procedure. Therefore, where graft loss is a possibility, inhibition of penile erections preoperatively may be a consideration. Antiandrogen treatment should be commenced 2 weeks before surgery in order to inhibit the erections.

The use of phosphodiesterase type 5 (PDE-5) inhibitors for penile rehabilitation following surgery has mainly been reported for post radical prostatectomy patients. However, following surgery to correct penile curvatures, particularly plaque incision and grafting procedures, PDE-5 inhibitors may have a role in restoring cavernosal smooth muscle function and encourage early erections.

A penile vacuum device can also be used prior to penile surgery in order to gain length before corrective surgery for penile curvature. Following grafting procedures for Peyronie's disease the vacuum device can help the graft to stretch.

Local anesthetic techniques for penile surgery

A number of penile procedures such as circumcision, dorsal slit, paraphimosis, release of penile skin entrapped in zippers and the treatment of penile lacerations can be performed under local anesthetic.

Penile block technique

The surgeon should ensure that local anesthetic agents *without* epinephrine or any other vasoconstricting agent are used for penile blocks to avoid the risk of penile ischemia and necrosis.

The right and left dorsal penile nerves should be blocked as proximally to the base of the penis as possible. Gentle traction on the penis to pull it forward is used to open up the space between the penis and symphysis pubis. A 22-gauge needle is inserted on either side of the midline under the symphysis pubis towards Buck's fascia. Aspiration is performed to ensure that the needle has not been inserted into a blood vessel, and approximately 2 mL of local anesthetic is injected. An alternative technique is to perform a penile ring block.

Penile shaft ring block

An alternative to using a penile block is to perform a circumferential ring block on the penile shaft using a 25-gauge needle. It is particularly important to anesthetize the frenulum to ensure complete anesthesia.

Conclusions

Patients undergoing genitourethral surgery require thorough preoperative counseling. Inevitably there are occasions where expectations are unmet and therefore surgeons performing high risk surgery or revision surgery should ensure that consultations are fully documented, preoperative stretched penile length is recorded as well as keeping accurate operative records.

Acknowledgments

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3

Basic Surgical Techniques

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Development of plastic surgery

It is difficult to find a concise definition for the role of plastic surgery. Its moniker finds its root in *plastikos*, a Greek word meaning to mold. Its cannon consists of a variety of techniques that can be applied to a surgical problem rather than a series of named procedures. Its clay is the skin, the subcutaneous tissues and the muscles, all of which are laid out according to how their specific attributes can be manipulated. In reconstructing defect A, you will create donor defect B. The art is to make both as functionally and aesthetically acceptable as is surgically possible.

Plastic surgery is widely thought to have originated in India around 600 BC with a surgeon called Sushruta. In his book, *Samhita*, he describes a technique for nasal reconstruction using a forehead flap. In sixteenth century Bologna, Tagliacozzi experimented with moving areas of skin and subcutaneous tissue on pedicles. This allowed tissue to be transported from one area of the body to another, temporarily connected by a skin bridge. His methods were unpopular and disregarded until rediscovered and revived in the nineteenth century by a German surgeon, von Graefe. It was von Graefe who coined the term “plastic.”

As with the rest of surgery it was the arrival of reliable anesthesia and asepsis that enabled true progress. The sheer volume of cases generated by World War I resulted in the expansion of the specialty started by Gilles in Aldershot, UK. Plastic surgery was also advancing in the USA, with pioneering work in maxillofacial injuries, techniques of phallic reconstruction, as well as reconstructive hand surgery. In the interwar years interest developed in the adaptation of reconstructive techniques for aesthetic concerns. World War II brought not only the same traumatic demands as its predecessor, but also burns on a scale not previously encountered, associated with the advances in aircraft combat.

The next paradigm shift came with the ability to operate on a smaller scale using microscopes which allowed the anastomosis of blood vessels. In 1962, Malt successfully reattached an amputated arm, and in 1968 Komatsu and Tamai a digit [1]. Taking the technique forward has allowed the flap concept to be taken to its logical conclusion, the microvascular free transfer, or the “free flap.” This sparked the explosion of reconstructive microsurgery and the re-evaluation of the body as a repository of “spare parts” that can be called upon.

The two elements that underpin reconstructive surgery are the blood supply to the skin and subcutaneous tissues and an understanding of the relaxed skin tension lines (RSTL). The former defines the boundaries of what is possible in reconstruction and the latter guides the design of incisions and skin flaps.

Skin

Skin is the largest organ in the body. It provides physical protection as well as protection against UV light and microbial invasion. It regulates fluid loss and body temperature, allows for sensation and immunologic surveillance. The epidermis is generated in the basal layer and consists predominantly of keratinocytes, although there are some melanocytes in its deepest layer, antigen presenting Langerhans’ cells and Merkel mechanoreceptor cells. The dermis, 95% of the thickness of skin, is divided into a papillary and a reticular layer. It is made up of collagen fibers in a ratio of (type I) 5 : 1 (type III), elastin and ground substance secreted by fibroblasts. Skin appendages such as hair follicles and glands (eccrine, sebaceous and apocrine) all reside in the dermis.

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The blood supply to the skin relies on a series of six plexuses that arise from the deep system of the main arterial tree:

1 Subepidermal;
2 Dermal;
3 Subdermal;
4 Subcutaneous;
5 Prefascial; and
6 Subfascial.

The subdermal plexus is the mainstay of the supply to the skin. The interconnecting vessels are classified according to their anatomic routes as either fasciocutaneous, which traverse fascial septa, or musculocutaneous, which enter the skin from the body of the underlying muscle.

Work in the late nineteenth century by Manchot and then by Salmon in the 1930s conceived the idea of the angiosome. This is an area of composite tissue that is supplied by a named artery. Taylor and Palmer [2] expanded this concept in 1987, publishing a map of the body describing how it could be broken down along lines of vascular supply. At the borders of these territories there is a degree of crossover.

As we all know, with aging comes the appearance of "lines." These belie the orientation of the collagen and elastin fibers in the underlying dermis and are referred to as the relaxed skin tension lines (RSTL; Figure 3.1). They are predictable and this allows the surgeon to place the incision such that it will be more camouflaged even in

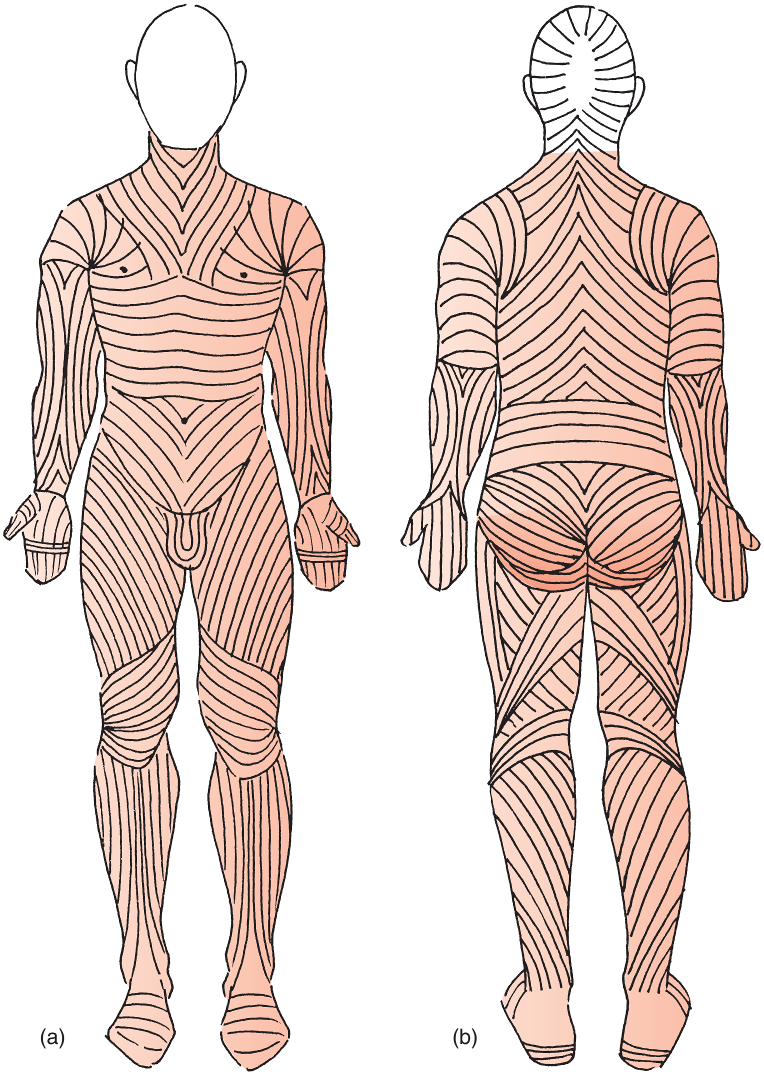


Figure 3.1 The direction of the relaxed skin tension lines varies across the body. (a) Anterior view; (b) posterior view.

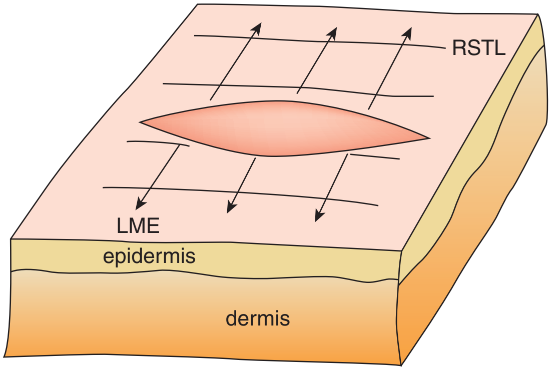


Figure 3.2 The relationship of the relaxed skin tension lines and lines of maximum extensibility. Planning incisions to capitalize on this natural skin laxity reduces the tension on a suture line.

young skin. However, they also indicate the direction of the lines of maximum extensibility (LME) or stretch (Figure 3.2). These run perpendicular to the RSTL and by planning the incision or excision with these in mind it is possible to reduce the tension on the wound edges during closure, ensure the greatest benefit in local flap movement and the best cosmesis.

Wound healing

Wound healing is a vast topic and one that can only be given a brief outline in this chapter. Tissue injury results in a cascade of processes that are designed to restore as much of the original function as possible. In the postnatal mammal this process results in fibrosis and scarring except in a few unusual circumstances in bone and the liver. The sequence of repair is divided into three phases: inflammatory, proliferative and remodeling.

Inflammatory: 0–7 days

This begins with hemostasis and the formation of a clot. The coagulation and complement cascades are initiated and the degranulation of platelets attracts inflammatory cells. There is an increase in local vascular permeability and margination of the inflammatory cells. Initially neutrophils, within 2–3 days the balance shifts towards monocytes which differentiate into phagocytic macrophages which in turn release growth factors promoting fibroblasts and keratinocytes.

Proliferative: 4 days–3 weeks

Fibroblasts migrate into the wound on a fibrin mesh and deposit extracellular matrix into the wound, laying down collagen on to the fibronectin and glycosaminoglycan scaffold [3]. Neoangiogensis results in the formation of a rich capillary network. This collection of blood vessels, fibroblasts and macrophages in a matrix of collagen and hyaluronic acid is called granulation tissue. Myofibroblasts initiate contraction, pulling the wound edges closer without the production of new tissue [4]. Keratinocytes at the wound margin migrate across the surface of the wound to restore the epidermis.

Remodeling: 3 weeks–2 years

Matrix metalloproteinases (collagenases) mediate a balance between synthesis and degradation of collagen [5]. Cross-linking increases the collagen's strength; however, it never regains the loose reticular orientation of unwounded skin. Tensile strength increases rapidly in the first 8 weeks and then more slowly for up to 1 year but only reaches approximately 80% that of normal skin [6].

Fetal skin in early gestation is capable of regenerative healing without scar formation. This process is only possible prior to the third trimester and is not dependent on the fetal environment [7]. Reduced inflammation is thought to have a crucial role in scarless fetal healing [8].

Nonhealing wounds are defined as those that do not close in more than 30 days. Pressure, infection, poor vascular inflow or outflow and neuropathy are common factors associated with nonhealing wounds. Radiotherapy damages fibroblast and keratinocyte DNA, reducing their ability to divide, together with endothelial cell damage results in an endarteritis and atrophy. Therefore irradiated tissue can result in wound breakdown with problematic wound healing [9]. Chemotherapy has a similar effect on cells involved in the proliferative phase of healing and should be postponed for at least a week post surgery [10].

Adequate nutrition is vital. The process of wound healing is anabolic and requires additional calorific intake [11]. Protein depletion has been shown in rats to increase the risk of wound dehiscence [12]. Obesity is associated with poor wound healing independent of glycemic control. probably as a result of poor tissue perfusion and vitamin and trace element deficiencies. Vitamins A, B1, B6 and C are involved in collagen synthesis and cross-linking [13]. Where a deficiency exists, correction can reduce the chances of wound healing problems. In particular, the demand for vitamin A is increased post injury and in animal studies it can reverse the healing impairment seen with steroids [14]. Trace elements such as zinc and copper are important cofactors in many enzyme reactions. Zinc in particular is related to epithelialization [15]. Corticosteroids, either topically or systemically, impair wound healing. The precise mechanism is unclear but there is a reduction in the inflammatory response, collagen synthesis and wound contraction [16]. The reduction in the inflammatory response can also increase the incidence of wound infection [17].

Reconstruction

Originally, plastic surgeons were taught to approach problems with reference to a "reconstructive ladder." This provides a systematic guide for escalating the surgical plan to reconstruct a defect. In more recent times this has been reinvented as the "reconstructive menu." This reflects a change in practice whereby surgeons will proceed directly to the reconstructive approach that is most suitable to each individual wound–patient complex (Figure 3.3).

Primary surgical closure

The perfect suture continues to elude us. The choice is dictated by location, demand and surgeon preference, realizing that any material will have pros and cons. Increasingly, absorbable sutures such as poliglecaprone are the mainstay. As a general rule, permanent sutures are removed at 12–14 days, except in the face where they are taken out at a week.

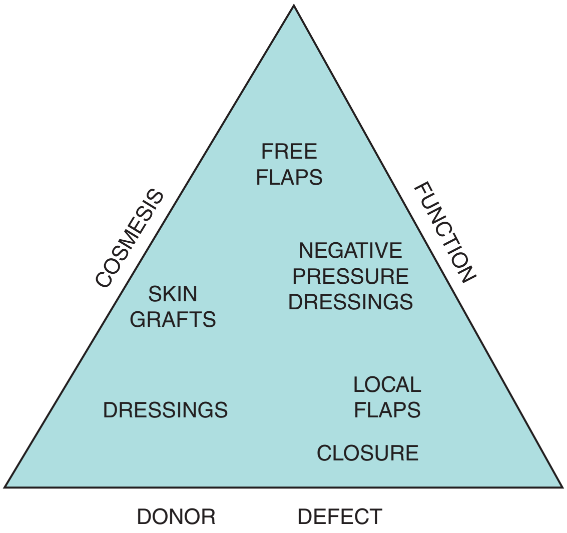


Figure 3.3 Reconstructive triangle.

Secondary closure

This is suitable for wounds with no exposed tendon, bone, prostheses or cartilage, and also no open fractures or necrotic tissue. It is a particularly useful technique in those where there is a significant anesthetic risk. It is vital to optimize the wound both systemically in terms of the blood supply, nutrition and diabetic control, and locally with debridement, elevation and appropriate dressings.

Skin grafts

This is an attempt to speed up the closure of open wounds through the use of either full thickness skin grafts (FTSG) or split thickness grafts (SSG). A graft is a unit of tissue with no discernable blood supply that relies on the wound bed for nutrition.

Graft "take" occurs through:

- Adherence;
- Serum imbibition;
- Inosculation and revascularization; and
- Remodeling [18].

The only contraindications to the use of skin grafts are an avascular bed, malignancy or infection so it is important to debride the wound bed adequately and exclude microbial infection. Chronic wounds that have been open for longer than a week are likely to be heavily colonized and grafting should be delayed until growth is below 10^5 organisms per gram of tissue [19]. Negative pressure dressings have become a very useful adjunct, encouraging the formation of granulation tissue in preparation for grafting [20].

In a FTSG the whole dermis is included. A FTSG requires a more vascular bed than a SSG but undergo less overall contraction [21]. FTSGs retain the ability to grow and therefore are preferred on most wounds in children [22]. The donor site is selected to replicate most accurately the skin of the defect in terms of color, texture, consistency and thickness. A template from the defect should be used to guide graft harvest. The donor site must be closed primarily as it retains no dermis from which to regenerate, which limits the size of graft that can be harvested. The graft can be secured with sutures and either quilting or a tie-over dressing to reduce sheer. Tie-over dressings do not generate pressure and therefore have little impact on sub-graft hematoma or seroma formation (Figures 3.4 and 3.5).

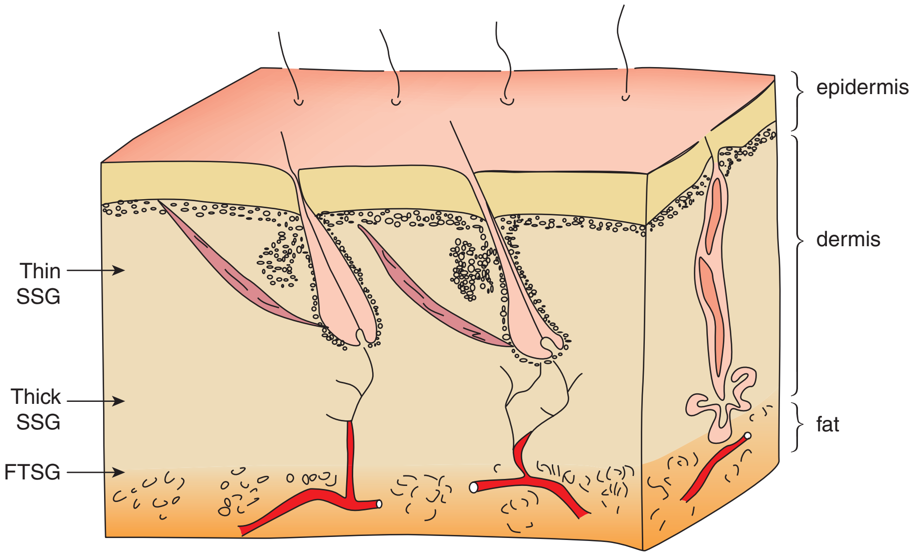


Figure 3.4 A cross-section of skin showing the depths for split thickness (SSG) and full thickness (FTSG) skin grafts. SSG, composed of epidermis and a variable amount of dermis, are used on the trunk, limbs and genitalia. They are harvested using a powered or free-hand dermatome although these require considerable operator experience to harvest skin of a consistently even thickness and size.

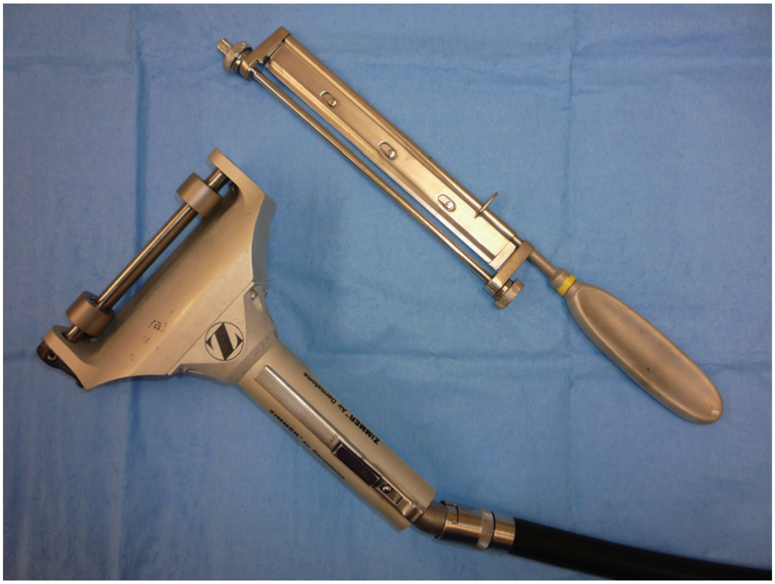


Figure 3.5 Air-powered dermatome and hand-held Watson knife.

Typically, grafts are 0.25–0.35 mm (0.009–0.015 inch) thick and can be placed as a sheet, perforated or meshed, which expands their potential surface area. Mesh ratios range from 1 : 1 to 6 : 1. Above 3 : 1 the graft becomes very friable and difficult to handle. The degree of secondary graft contraction is directly proportional to the expansion which is of particular significance when grafting across joint surfaces [23]. After meticulous hemostasis grafts are fixed in place with fibrin glue, sutures, or clips. Dressings consist of a nonadherent layer, gauze to fill in the contour defect and an adherent dressing to reduce sheer. The graft is checked at 2–5 days. Ordinarily the donor site is covered with a simple dressing which remains in place until the wound has re-epithelialized at 14 days. Because dermis remains at the donor site it will heal spontaneously and thus the size of graft that can be harvested is large and a single donor site can be reused several times. While the donor site does not produce a scar there is often an area of altered pigmentation, especially in individuals with darker skin.

Flaps

A flap is a unit of tissue that can be mobilized on its own blood supply and intrinsic circulation or can have its intrinsic blood supply reestablished via microscopic techniques. Flaps can be subdivided according to:

1 Blood supply:
  a. Random;
  b. Axial.
2 Flap movement:
  a. Local (pivot/advancement);
  b. Island;
  c. Free.
3 Composition:
  a. Skin;
  b. Fascia;
  c. Muscle;
  d. Bone;
  e. Combination of above.

Local flaps are supplied by the subdermal plexus of blood vessels in a random pattern. This limits their length : breadth ratio to 1 : 1 on the body and 4 : 1 on the face. They can be used to cover adjacent defects with aesthetically similar tissue, even when the wound bed would be unable to sustain a graft. They are described through their geometry (Figure 3.6).

A variant, the Z-plasty, has extensive applications in lengthening and disguising scars [24]. The transposition of two adjacent triangular flaps recruits skin laxity from alongside a scar to release contracture. In so doing the direction of the central limb of the incision is translated and thus breaks up a scar. The percentage gain in length is proportional to the apex angle of the triangle but care must be taken not to violate the length : breadth ratio and cause necrosis of the tip, especially in heavily scarred skin (Table 3.1; Figure 3.7).

The angiosome principle underpins both island and free flaps. The distinction lies in the microsurgical reanastomosis of the pedicle to a donor blood supply in free tissue transfer. This increases the distance that the flap can be moved and hence the number of flaps available to tailor each reconstruction. The drawback is that it relies on the availability of donor vessels and is more vulnerable to surgical skill and the physiology of the patient (Table 3.2).

Microsurgical techniques allow the patent anastomosis of small vessels down to approximately 1 mm diameter. When any blood vessel is divided the processes of repair are initiated. Following exposure of the endothelium and damage to the intima the clotting cascade is triggered and a platelet plug forms. In the case of a microsurgical anastomosis this plug seals the repair. This plug dissolves and is replaced by pseudointima over 3–5 days and new endothelium by 2 weeks. The stability of the repair over the first 5 days is critical to the success of the anastomosis [25]. Endothelial damage extending beyond the suture line will continue to trigger platelet activation and eventually thrombus formation.

There are scenarios where the microsurgical approach and free flap reconstruction are contraindicated. Flap harvest, microsurgical anastomosis and flap inset can take several hours, which can preclude those patients who cannot tolerate prolonged anesthesia. Any form of coagulopathy will exacerbate the issues of thrombus formation. Cardiovascular disease, peripheral vascular disease, diabetes mellitus, renal disease, radiation, scleroderma and Raynaud's syndrome, to name but a few, can affect both blood flow and the condition of the vessel walls [26]. Smoking reduces cutaneous blood flow and wound healing. All these factors increase the risks of flap failure.

Island and free flaps have been classified according to their content and their blood supply to assist in identifying the best choice in each individual reconstruction. In 1981, Mathes and Nahai [27] designed a system to describe muscle-based flaps. These can be raised with or without the overlying skin paddle (Table 3.2). It is also possible to include the nerve to the muscle flap and coapt it to a donor nerve to restore loss of muscle in the case of facial palsy and brachial plexus injury.

Several flaps have been described where the skin paddle was raised on a vessel that ran in the septa between

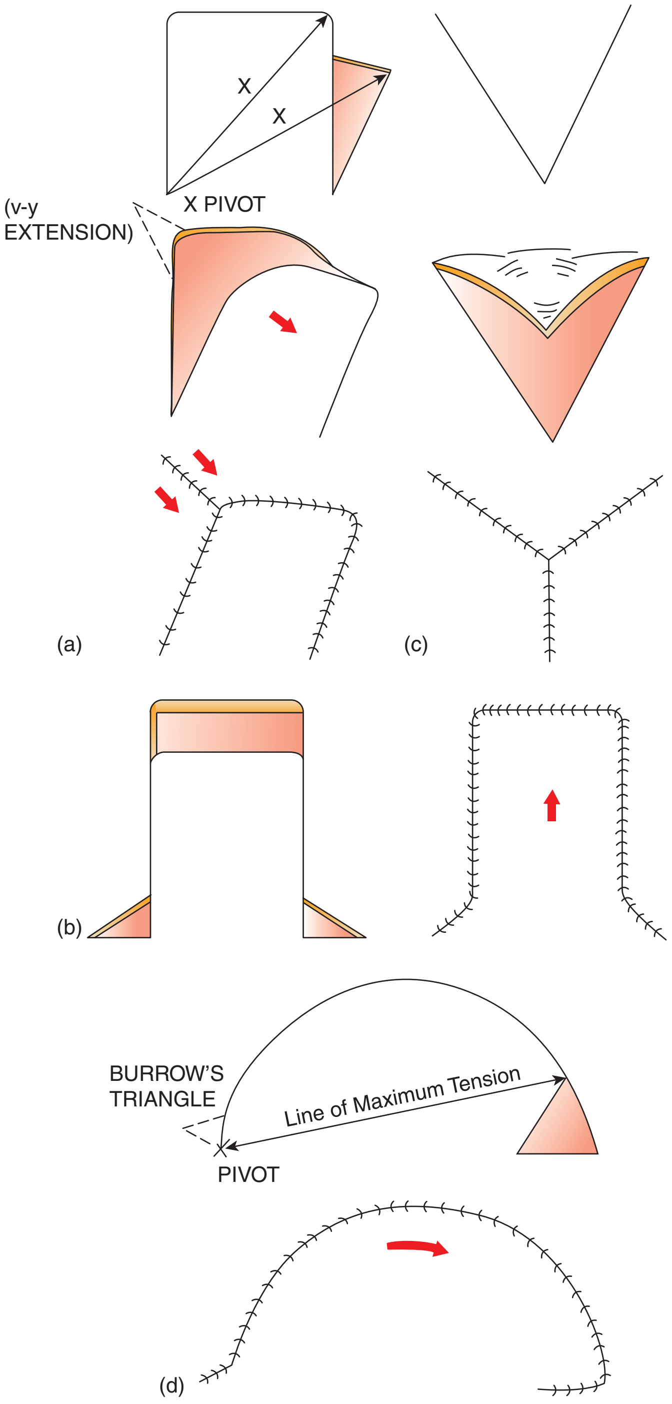


Figure 3.6 (a) Transposition, (b) advancement, (c) V–Y advancement and (d) rotation flaps.

Table 3.1 Increase in length of main limb of a Z-plasty with changes in the angle of the Z

Angle (°)	Gain in length (%)
30	25
45	50
60	75
75	100

muscles allowing the muscle to be left undisturbed. In 1984, Cormack and Lamberty [28] classified these fasciocutaneous flaps. These have evolved into the perforator flaps (e.g. the anterolateral thigh flap [29]) which have been popularized in the last few years.

The selection of the appropriate flap is vital to achieving soft tissue cover as well as restoring a functional and, it is hoped, an aesthetically acceptable outcome. As microsurgical techniques have become more predictable

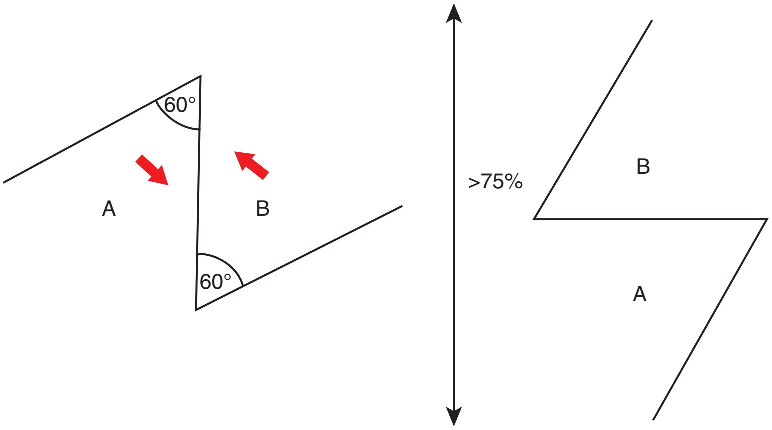
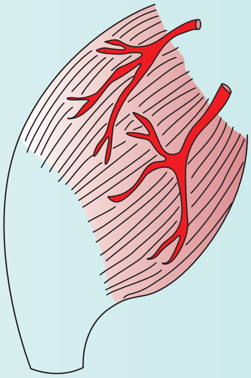


Figure 3.7 Z-plasty.

Table 3.2 Classification of muscle flaps based on their blood supply according to the Mathes and Nahai principle

Type	Pedicle	Image	Examples
1	Single primary vascular pedicle that can support the flap		Gastrocnemius Tensor fascia lata Colon Jejunum Vastus lateralis

(*Continued*)

Table 3.2 (*Continued*)

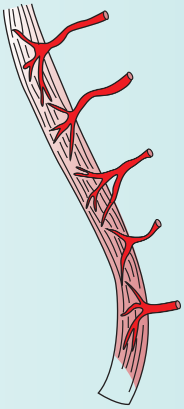
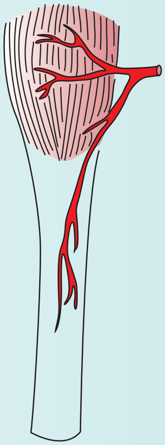
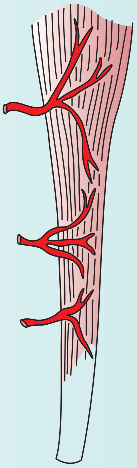
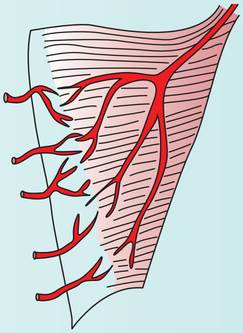
Type	Pedicle	Image	Examples
2	Single primary pedicle and one or more minor pedicles The flap can only survive on the dominant system		Gracilis Trapezius Triceps Vastus medialis Sternocleidomastoid Biceps femoris
3	Two main vascular pedicles, either of which can support the flap		Gluteus maximus Rectus abdominis Pectoralis minor Omentum
4	Segmental vascular pedicles. Division of two or more vessels results in muscle necrosis		Sartorius External oblique

Table 3.2 (*Continued*)

Type	Pedicle	Image	Examples
5	Single primary and secondary segmental vascular pedicles The flap can survive on either system		Latissimus dorsi Pectoralis major Internal oblique

it has become more commonplace to move to the reconstruction that can achieve the most rather than the simplest rung of the ladder that will suffice.

References

1 Malt RA, McKhann C. Replantation of several arms. JAMA 1964;189:716–22.

2 Taylor GI, Palmer JH. The vascular territories (angiosomes) of the body: Experimental study and clinical applications. Br J Plast Surg 1987;40(2):113–41.

3 Singer AJ, Clark RA. Cutaneous wound healing. N Engl J Med 1999;341(10):738–46.

4 Gabbiani G. Evolution and clinical implications of the myofibroblast concept. Cardiovasc Res 1998;38(3):545–8.

5 Soo C, Shaw WW, Zhang X, Longaker MT, Howard EW, Ting K. Differential expression of matrix metalloproteinases and their tissue-derived inhibitors in cutaneous wound repair. Plast Reconstr Surg 2000;105(2):638–47.

6 Levenson SM, Geever EF, Crowley LV, Oates JF, Berard CW, Rosen H. The healing of rat skin wounds. Ann Surg 1965;161:293–308.

7 Longaker MT, Whitby DJ, Adzick NS, Crombleholme TM, Langer JC, Duncan BW, et al. Studies in fetal wound healing, VI. Second and early third trimester fetal wounds demonstrate rapid collagen deposition without scar formation. J Pediatr Surg 1990;25(1):63–8; discussion 68–9.

8 Cowin AJ, Brosnan MP, Holmes TM, Ferguson MW. Endogenous inflammatory response to dermal wound healing in the fetal and adult mouse. Dev Dyn 1998;212(3):385–93.

9 Bernstein EF, Harisiadis L, Salomon GD, Harrington F, Mitchell JB, Uitto J, et al. Healing impairment of open wounds by skin irradiation. J Dermatol Surg Oncol 1994;20(11):757–60.

10 Drake DB, Oishi SN. Wound healing considerations in chemotherapy and radiation therapy. Clin Plast Surg 1995;22(1):31–7.

11 Barbul A, Purtill WA. Nutrition in wound healing. Clin Dermatol 1994;12(1):133–40.

12 Modolin M, Bevilacqua RG, Margarido NF, Lima-Gonçalves E. Effects of protein depletion and repletion on experimental open wound contraction. Ann Plast Surg 1985;15(2):123–6.

13 Goodson WH, Hunt TK. Deficient collagen formation by obese mice in a standard wound model. Am J Surg 1979;138(5):692–4.

14 Ehrlich HP, Hunt TK. Effects of cortisone and vitamin A on wound healing. Ann Surg 1968;167(3):324–8.

15 Lansdown AB, Sampson B, Rowe A. Sequential changes in trace metal, metallothionein and calmodulin concentrations in healing skin wounds. J Anat 1999;195(Part 3):375–86.

16 Marks JG, Cano C, Leitzel K, Lipton A. Inhibition of wound healing by topical steroids. J Dermatol Surg Oncol 1983;9(10):819–21.

17 Ehrlich HP, Hunt TK. The effects of cortisone and anabolic steroids on the tensile strength of healing wounds. Ann Surg 1969;170(2):203–6.

18 Smahel J. The healing of skin grafts. Clin Plast Surg 1977;4(3):409–24.

19 Gingrass P, Grabb WC, Gingrass RP. Skin graft survival on avascular defects. Plast Reconstr Surg 1975;55(1):65–70.

20 Argenta LC, Morykwas MJ. Vacuum-assisted closure: A new method for wound control and treatment – clinical experience. Ann Plast Surg 1997;38(6):563–76; discussion 577.

21 Ragnell A. The secondary contracting tendency of free skin grafts; an experimental investigation on animals. Br J Plast Surg 1952;5(1):6–24.

22 Baran NK, Horton CE. Growth of skin grafts, flaps, and scars in young minipigs. Plast Reconstr Surg 1972;50(5): 487–96.

23 Fifer TD, Pieper D, Hawtof D. Contraction rates of meshed, nonexpanded split-thickness skin grafts versus split-thickness sheet grafts. Ann Plast Surg 1993;31(2):162–3.

24 Borges AF, Gibson T. The original z-plasty. Br J Plast Surg 1973;26(3):237–46.

25 Hayhurst JW, O'Brien BM. An experimental study of microvascular technique, patency rates and related factors. Br J Plast Surg 1975;28(2):128–32.

26 Moran SL, Illig KA, Green RM, Serletti JM. Free-tissue transfer in patients with peripheral vascular disease: A 10-year experience. Plast Reconstr Surg 2002;109(3):999–1006.

27 Mathes SJ, Nahai F. Classification of the vascular anatomy of muscles: Experimental and clinical correlation. Plast Reconstr Surg 1981;67(2):177–87.

28 Cormack GC, Lamberty BG. A classification of fasciocutaneous flaps according to their patterns of vascularisation. Br J Plast Surg 1984;37(1):80–7.

29 Song YG, Chen GZ, Song YL. The free thigh flap: A new free flap concept based on the septocutaneous artery. Br J Plast Surg 1984;37(2):149–59.

4

Congenital Penile Abnormalities

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Circumcision

Although the historic origins of circumcision are unclear, the practice has been carried out for either cultural or religious reasons throughout the world for centuries. The word circumcision originates from Latin: *circum* meaning around and *caedere* meaning to cut. The goal of the procedure is to remove sufficient preputial skin to leave the glans exposed.

Clinical features

Although the majority of pediatric circumcisions are performed for cultural or religious reasons (Islam, Judaism), the presence of a pathologic phimosis secondary to lichen sclerosus et atrophicus is an absolute indication for circumcision. However, an understanding of the natural history of the foreskin allows clinicians to differentiate a "physiologic phimosis," whereby gentle retraction shows the inner preputial layer coming into view, from a true pathologic phimosis.

At birth only 4% of boys have a fully retractile foreskin. By the age of 3 years approximately 10% of boys continue to have a physiologic phimosis. However, by the age of 16 years only 1% have a nonretractile foreskin.

Surgical technique

Methods for circumcision in the newborn infant using the Gomco, Plastibell or Mogan devices have been well described. In children over the age of 3 months, the use of these devices is associated with a higher risk of bleeding [1]. Consequently, a sleeve circumcision is the preferred surgical technique. After initiation of general anesthesia, a penile nerve block is placed dorsally and ventrally by the surgeon or anesthesiologist using 0.25% bupivacaine or ropivacaine *without* epinephrine, as demonstrated in Figure 4.1. Injection ventrally in the scrotal midline provides pain control at the frenulum which is supplied by a branch of the perineal nerve (Figure 4.2) [2]. We prefer a penile rather than a caudal block for most penile surgery as it has been associated with equivalent pain control with a faster time to incision and quicker discharge home [3].

The foreskin is manually reduced (Figure 4.3), or, when necessary, a dorsal slit (Figure 4.4) followed by manual reduction is performed. Once the foreskin has been reduced, an incision line is marked circumferentially approximately 5 mm below the glans penis to create a mucosal collar (Figure 4.5). A second circumferential line is marked around the penile shaft skin at the corresponding level. The incisions are then performed circumferentially at these two sites; we prefer a Beaver blade knife holder with a 69 blade. The skin and the dartos layer between the two incisions are excised sharply. Once hemostasis is achieved, the skin edges are reapproximated using a running subcuticular 7-0 polyglactin on a TG 140-8 needle in prepubertal boys, and 5-0 polyglactin in postpubertal boys. We avoid the use of chromic suture through the epithelium due to the risk of creating suture tracks in these patients. Alternatively, reapproximation of the skin edges using 2-octyl cyanoacrylate instead of suture in pre-pubertal patients has been reported and may be less expensive due to shorter operating room time [4].

Surgical complications

1 *Bleeding.* Meticulous hemostasis at the time of surgery should reduce the need for re-exploration. However,

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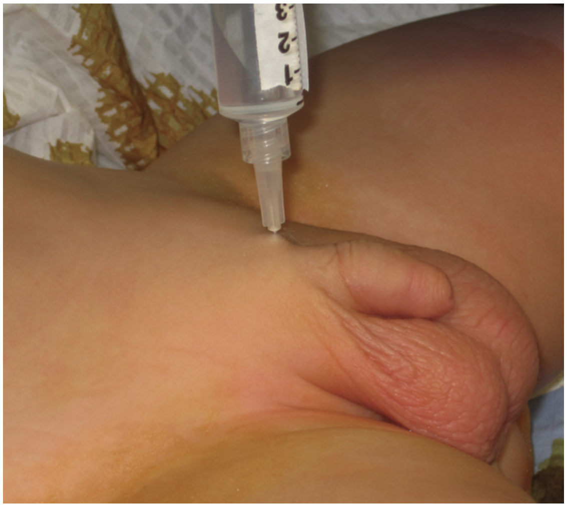

Figure 4.1 A dorsal penile nerve block is used for penile surgery by injecting 0.25% bupivacaine *without* epinephrine on either side of the midline. The penis can be gently pulled downwards in order to increase the space between the pubic bone and penile shaft.

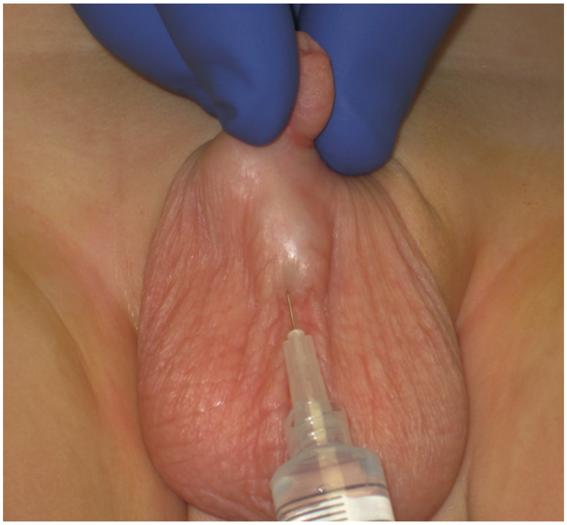

Figure 4.2 Local anesthetic is also injected at the penoscrotal junction to anesthetize the frenulum.

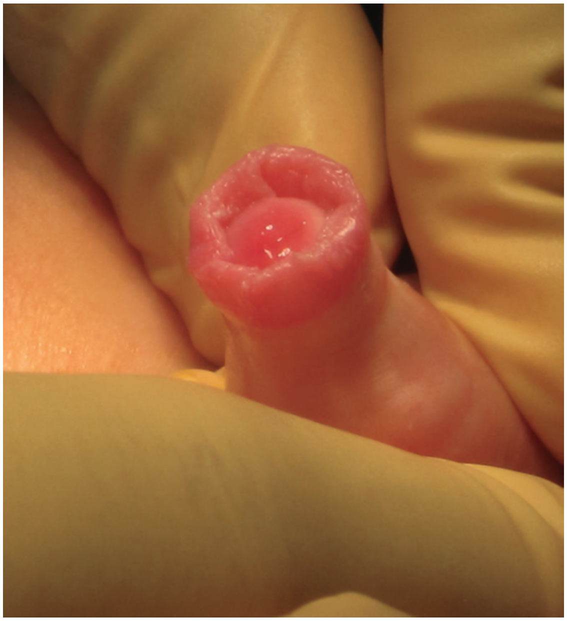

Figure 4.3 The foreskin is manually reduced prior to marking the incision lines during circumcision and phalloplasty.

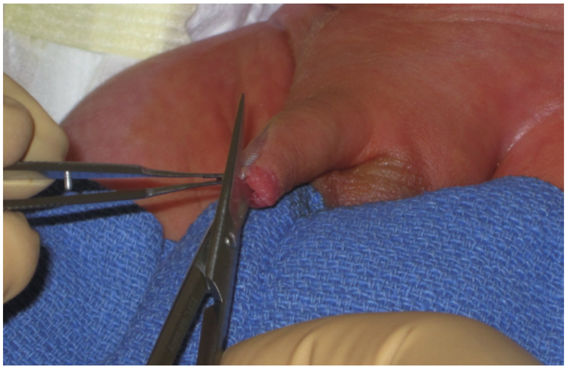

Figure 4.4 A dorsal slit can be performed in cases where manual reduction of the foreskin is not possible because of the presence of phimosis. A straight hemostat is used to crush the dorsal foreskin at the 12 o'clock position to the level of the glans penis, and the skin is then cut along the line left by the hemostat ensuring that the scissors do not enter and damage the urethral meatus.

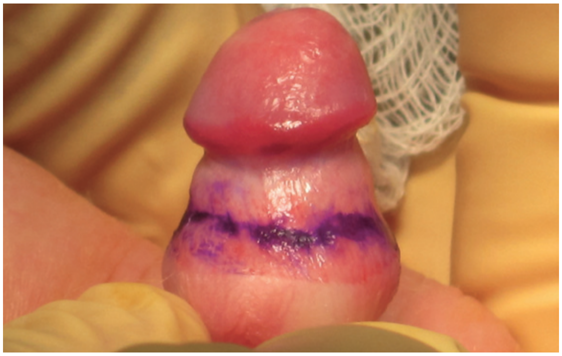

Figure 4.5 A circumferential incision line is marked approximately 5 mm proximal to the glans penis.

undiagnosed bleeding disorders can result in problematic bleeding postoperatively.

2 *Incorrect prepuce excision.* Either too much of the prepuce (resulting in a buried penis) or too little of the prepuce (resulting in a neoforeskin) can be avoided by using a skin marker to guide the incisions. In obese patients the penis can retract into the suprapubic fat pad and develop further lichen sclerosus and a recurrent phimotic scar.

3 *Poor cosmesis.* Inappropriately placed tight interrupted sutures placed circumferentially result in the development of lymphedema between the suture lines and a subsequent "sunflower" effect.

Fortunately, very rare complications such as glans amputation or penile degloving are typically associated with untrained personnel conducting the procedure.

Preputioplasty

Symptomatic phimosis can be treated using the triple-incision technique, which preserves the foreskin, assuming that there is no lichen sclerosus present [5,6].

Following retraction of the foreskin, a longitudinal incision is performed at three points on the phimotic band. These are then sutured transversely using 5-0 absorbable sutures (Figure 4.6).

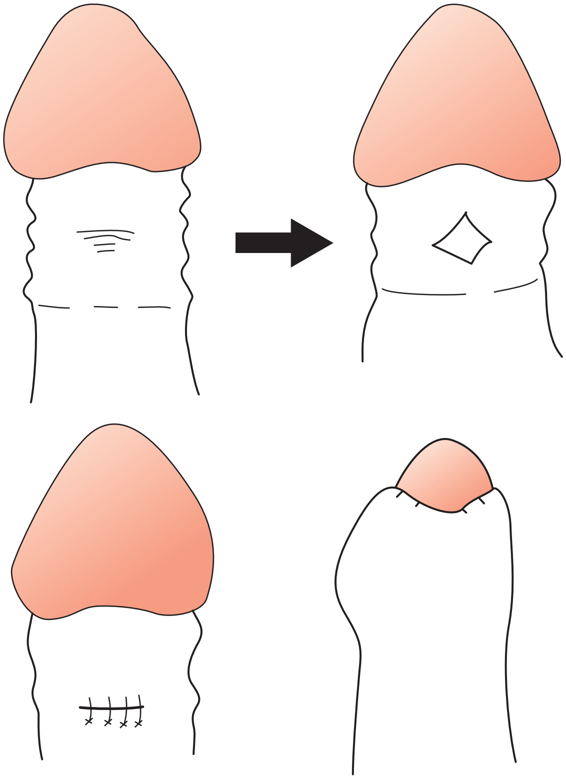

Figure 4.6 Preputioplasty performed for mild nonpathological phimosis.

Phalloplasty (congenital curvature, penile torsion, congenital webbed penis)

Congenital penile deviations are a result of asymmetric development of the tunica albuginea and corpus cavernosum. Isolated congenital curvature in the absence of hypospadias is rare. Generally, the flaccid penis is straight with penile deviation evident on erection. Ventral curvature of the penis has been attributed to the existence of a "congenital short urethra," however, in the absence of an associated abnormal development of the corpus spongiosum, this condition should be doubted and this abnormal development of the corpus spongiosum is really a form of hypospadias. Congenital shortness of the ventral penile skin or the presence of fibrous tissue on the ventral aspect of the corpus cavernosum can also cause ventral curvature.

Surgical technique

The initial approach is as detailed above for circumcision. However, we often place a stay stitch using 5-0 polypropylene through the glans to assist with retraction of

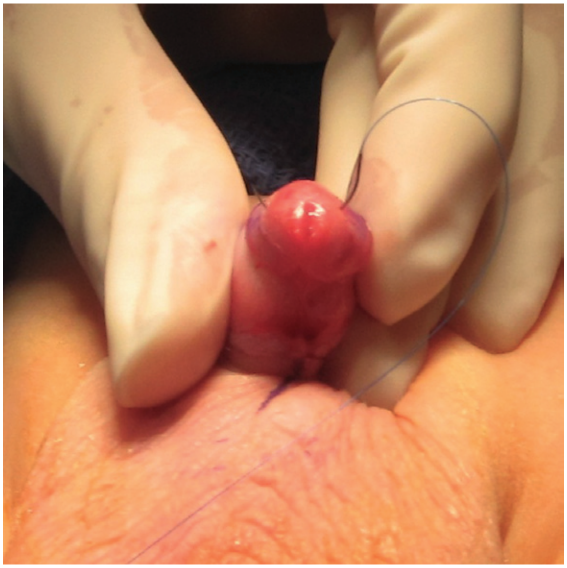

Figure 4.7 A stay stitch using 5-0 polypropylene through the glans assists with retraction of the penis.

the penis (Figure 4.7). After incising at the level of the mucosal collar circumferentially, the penis is degloved using tenotomy scissors to the level of the penoscrotal junction. In some cases an incision along the median raphe extended to the scrotum improves exposure (Figure 4.8). After complete degloving, we use a 23-gauge butterfly needle and 10 mL of injectable saline to induce an artificial erection and evaluate the degree of penile torsion and/or curvature that remains following degloving (Figure 4.9). A tourniquet can be placed around the base of the penis in order to induce an artificial erection; alternatively, manual compression of the corporal bodies at the base of the scrotum is also effective, or simple injection without compression is often satisfactory. Residual curvature less than 30° can be corrected with a single tunica albuginea plication in the area opposite to the maximal curvature. A small incision exposes Buck's fascia and then a 6-0 polypropylene suture is placed as depicted in Figure 4.10 [7]. An artificial erection is then repeated in order to ensure adequate straightening of the penis. Curvature greater than 30° is unusual without proximal hypospadias, and its correction is described later in the chapter.

Simple degloving with release of the dartos at the penoscrotal junction may reduce penile torsion. Persistent torsion is corrected using a dorsal dartos flap rotation [8].

Penoscrotal webbing can be corrected by performing an inverted "V" incision on either side of the web which

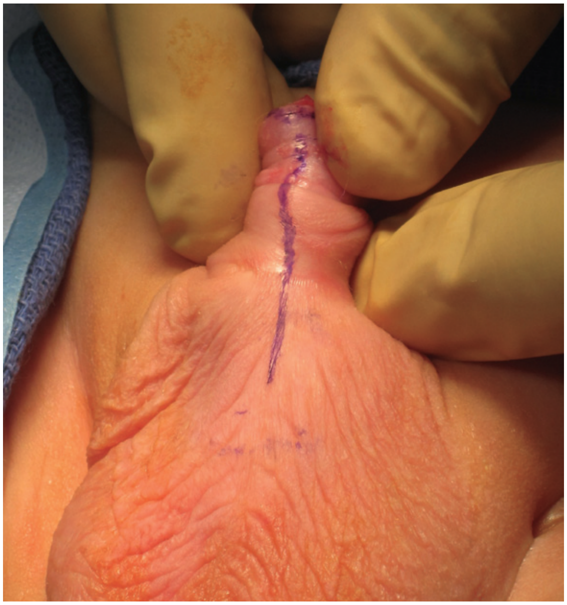

Figure 4.8 For additional exposure during phalloplasty, a midline incision along the median raphe in addition to the circumferential incision of the mucosal collar is performed. This can be extended to the scrotum for dissection at the penoscrotal junction.

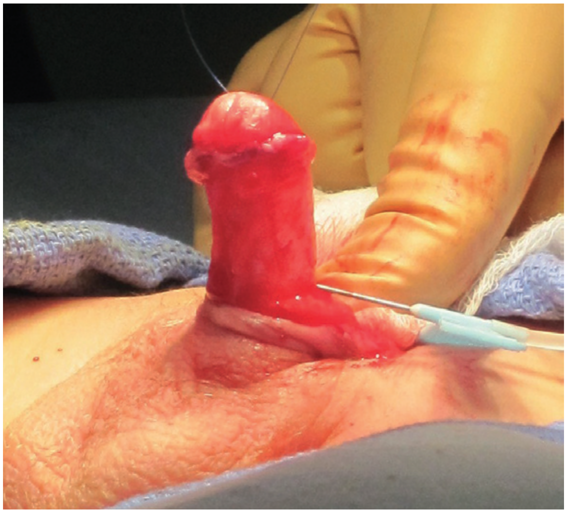

Figure 4.9 Artificial erection using injectable saline through a 25-gauge butterfly needle with either manual compression of the corporal bodies or a tourniquet at the base of the penis can identify residual curvature and/or torsion of the penis after degloving.

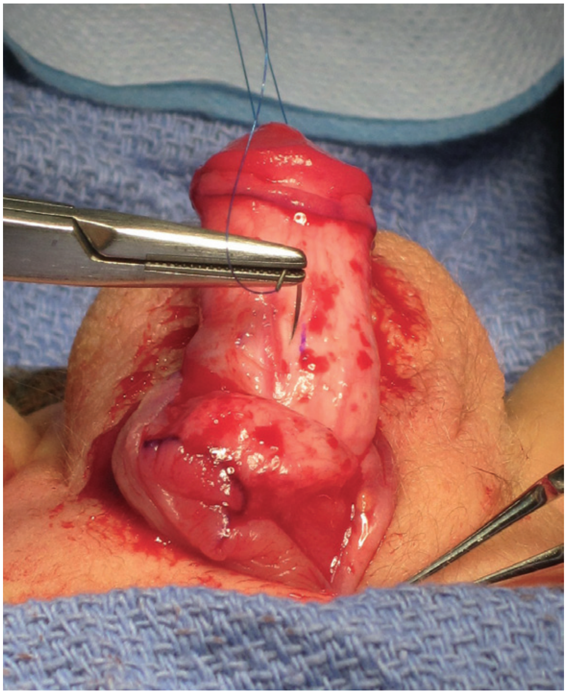

Figure 4.10 Baskin plication stitch: the tunica albuginea is incised opposite the point of maximum ventral curvature at the 12 o'clock dorsal surface, and a 6-0 polypropylene suture is placed, burying the knot.

allows the skin to drop down into the scrotum. A new penoscrotal junction is created by suturing the ventral shaft skin along the base of the penis to the corpora cavernosa on either side of the urethra with subepithelial 6-0 polydioxanone, taking care to avoid dimpling the skin.

Congenital concealed penis (megaprepuce)/penile unburying

This condition is characterized by an abundance of inner preputial skin, relative deficiency of the outer shaft skin and a tight phimotic ring. Ballooning occurs during urination, as urine fills the inner preputial sac and then dribbles out (Figure 4.11).

Surgical technique

A vertical incision is made at the 6 o'clock position through the phimotic ring and the penis is exposed (Figure 4.12). A stay suture of 5-0 polypropylene is placed through the glans for retraction, and then a

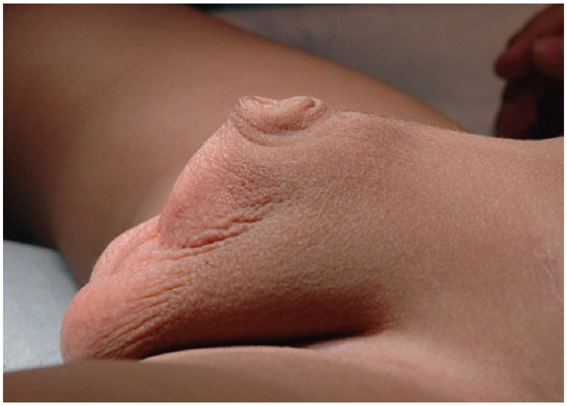

Figure 4.11 Congenital megaprepuce/buried penis preoperative appearance.

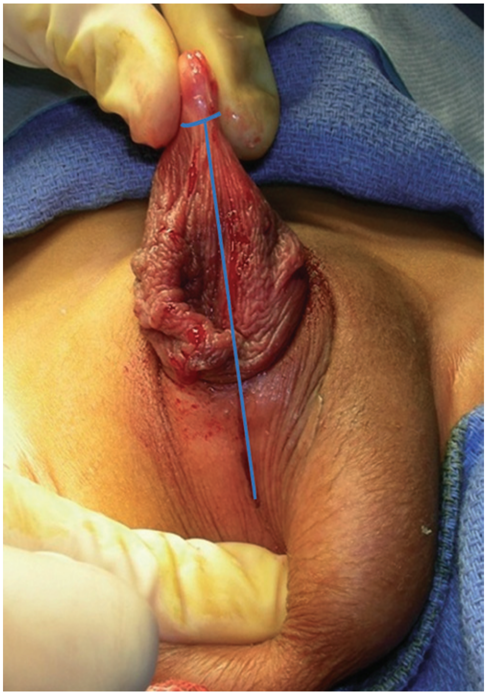

Figure 4.12 After incising the phimotic ring at the 6 o'clock position and exhuming the penis, a glans stay stitch is placed and incision lines (shown in blue) are marked circumferentially along the mucosal collar and vertically along the median raphe to the level of the mid scrotum in order to facilitate complete penile degloving.

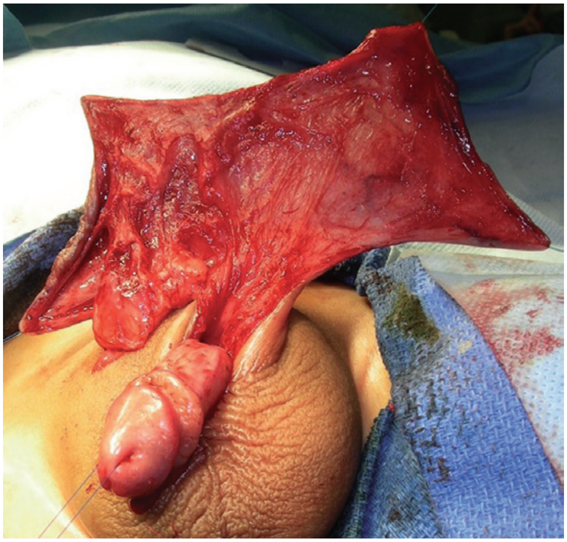

Figure 4.13 The penis is degloved, unfurling abnormally adherent and abundant inner preputial skin as well as normal shaft skin.

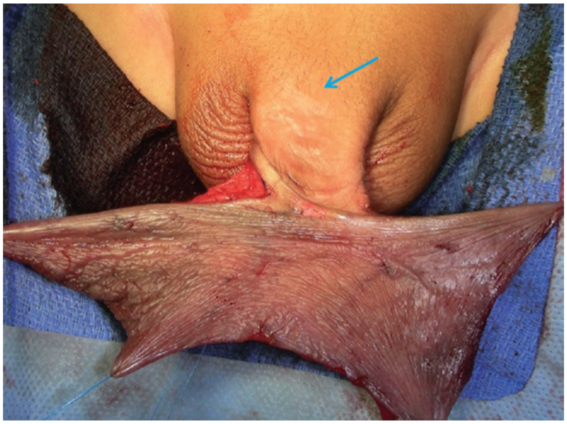

Figure 4.14 Normal shaft skin that will comprise the dorsal surface of the penis is visualized. The point corresponding to the 12 o'clock penopubic junction is selected (blue arrow) and a polypropylene suture is placed at the corresponding location to secure the dartos of the penile skin to the tunica albuginea.

circumferential incision is made 5 mm below the glans penis to create the mucosal collar. The penis is degloved, releasing the excessive inner preputial skin (Figure 4.13). A 5-0 or 6-0 polydiaxanone stitch is placed at the 12 o'clock position to create the penopubic junction, securing the dartos of the penile shaft skin to the tunica albuginea without dimpling the overlying skin (Figure 4.14).

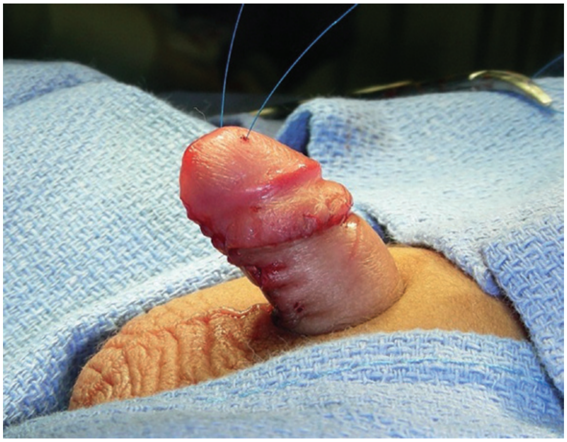

Figure 4.15 Congenital megaprepuce postoperative appearance after wrapping the degloved shaft skin around the ventral surface, securing the penoscrotal junction with 6-0 polydioxanone, creating a ventral median raphe using interrupted subepithelial 7-0 polyglactin suture and completing the circumcision.

The remaining shaft skin is then wrapped around the penis to cover the ventral surface. The penoscrotal junction is established with two 6-0 polydioxanone sutures sewn to the tunica albuginea on either side of the urethra. When sufficient ventral shaft skin is present, the median raphe is created using interrupted subepithelial 7-0 polyglactin. We use a full thickness skin graft from the groin to replace the ventral defect that occurs in some patients with inadequate shaft skin, preferring this to the alternative of covering the penile shaft using the excessive inner preputial skin. The immediate postoperative appearance is demonstrated in Figure 4.15.

Hypospadias

Hypospadias is a congenital abnormal development of the urethra resulting in the urethral opening being displaced to the ventral aspect of the penis anywhere between the proximal glans penis and the scrotum and perineum. The classification and surgical technique for repair depends on the position of the urethral meatus (Figure 4.16).

The aim of the repair is to achieve a straight penis to allow for adequate sexual function, creation of a functional neourethra, and repositioning of the urethral meatus with a cosmetically normal glans and penile shaft.

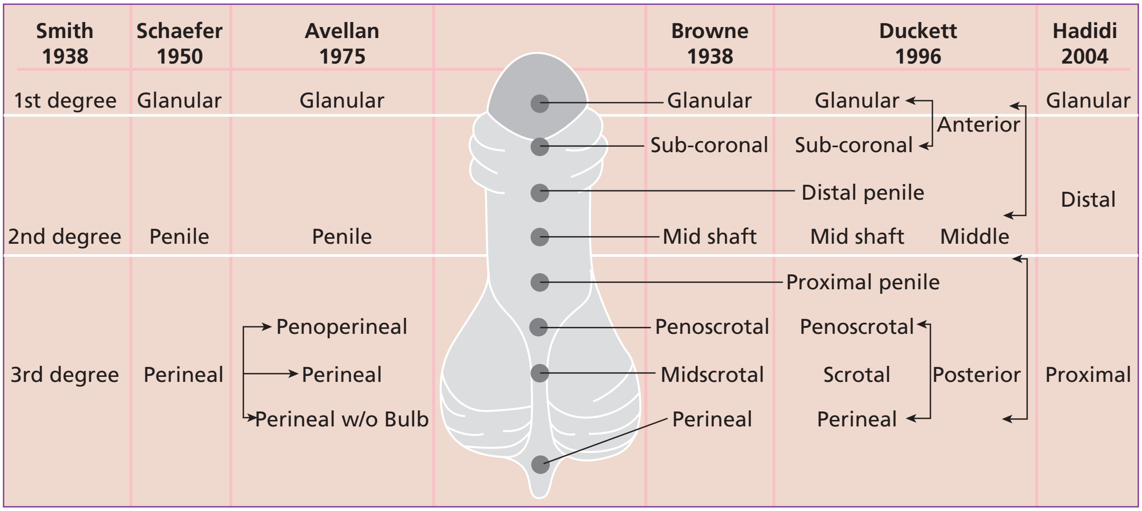

Figure 4.16 Classification of hypospadias. (Source: modified from Hadidi AT, Azmy A (eds) Hypospadias Surgery, An Illustrated Guide, Heidelberg, Germany, Springer Verlag (2004). Reproduced with kind permission of Springer Science and Business.)

Instruments

- 0.5 forceps
- Castroviejo needle holders
- Technique needle holder
- One caliper
- Two vein retractors
- Two Army N retractors
- Two small Richardson retractors
- Two tenotomy scissors
- One Beaver blade knife holder
- Five small hemostats
- Two Gerald forceps
- Two Adson forceps with teeth
- One mouth retractor
- 8-Fr sound
- Eye cautery
- Fine tip marking pen
- Vessel loop
- 23-gauge butterfly needle and injectable saline
- 6-Fr polyurethane (Kendall) stent
- Medium and large Tegaderm
- 30-gauge needle
- Blue bulb irrigator
- Beaver 69 blade
- Keith needle
- 1 : 100,000 U/mL epinephrine with lidocaine
- 1 : 1000 U/mL epinephrine

Surgical techniques

Distal repair with circumcision: tubularized incised plate (TIP) urethroplasty

A 5-0 polypropylene stay suture is placed through the glans penis to allow retraction. The initial skin incision preserves the inner prepuce for later ventral mucosal collar reconstruction (Figure 4.17) [9]. We prefer the 69 scalpel blade, and incise the skin overlying the urethra superficially to avoid inadvertent injury. The penis is degloved, dissecting immediately under the skin ventrally to preserve the ventral dartos which can be used for a later barrier flap. Dorsally, dissection is performed along Buck's fascia, leaving the dartos attached to the shaft skin.

An artificial erection is performed as described above. Ventral curvature is encountered in only 15% of patients, and in most cases the angle is less than 30°. This is corrected by a single dorsal plication using 6-0 polypropylene (Figure 4.10).

The glans wings are marked (Figure 4.18a) and then injected with 1 : 100,000 U/mL epinephrine with lidocaine to minimize bleeding. Mirror image incisions are made along the visual junction of the urethral plate within the glans using a 69 blade on a Beaver knife handle. Tenotomy scissors are then used to extend the dissection down to the underlying corpora cavernosa and laterally to ensure subsequent tension-free approximation (Figure

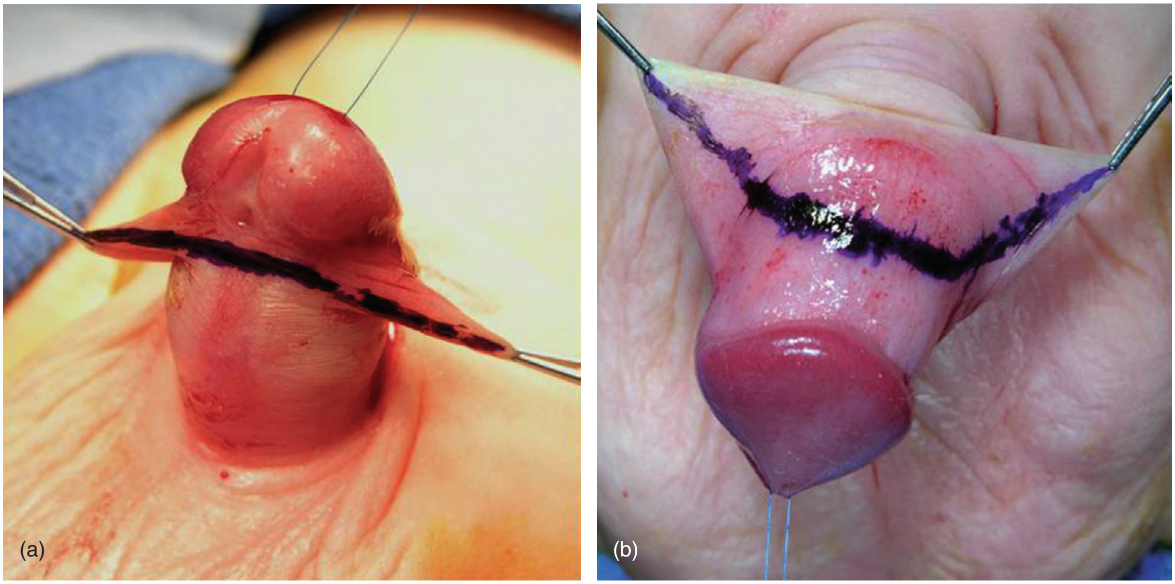

Figure 4.17 (a) Initial ventral marking for tubularized incised plate (TIP) repair with circumcision. (b) Dorsal skin marking of Firlit skirts.

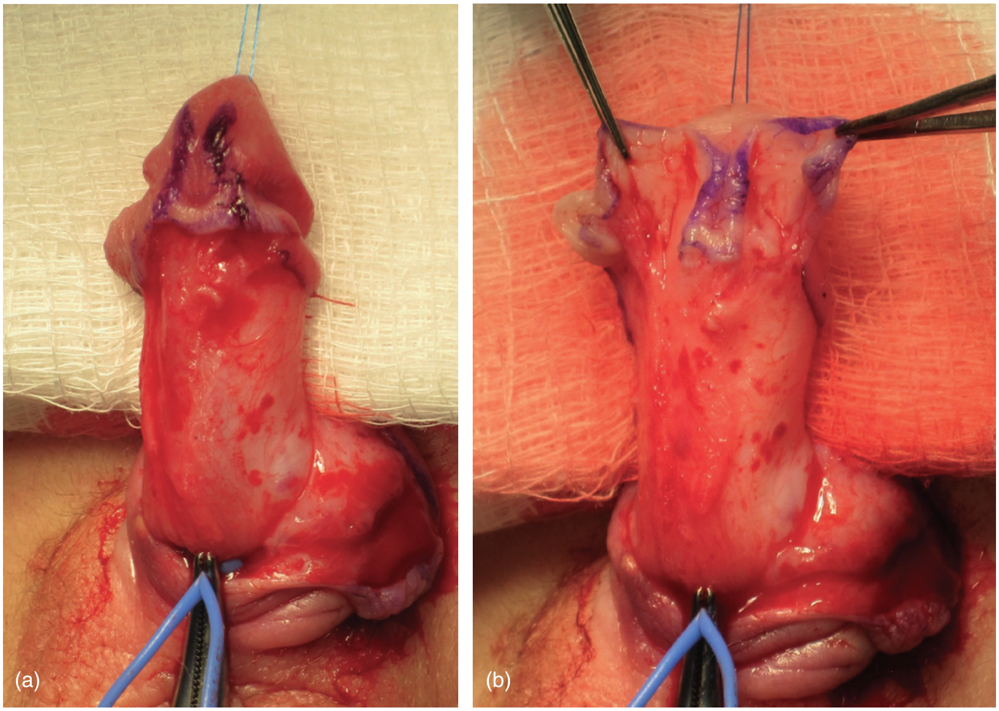

Figure 4.18 (a) Glans wings incisions are marked at the visual junction of the urethral plate within the glans and then injected with 1:100,000 U/mL epinephrine prior to incision with a 69 blade on a Beaver knife handle. (b) Tenotomy scissors are then used to extend the dissection such that the mobilization angle of the glans wings to the urethral plate is mobile enough to close without tension, approximately 90° in most patients.

4.18b). In patients with maximum glans width <14 mm, further mobilization of the glans wings is performed by advancing the dissection along the surface of the corpora at 3 and 9 o'clock, extending the dissection from proximal to distal for about 4 mm. Bleeding despite epinephrine injection is controlled using a tourniquet at the base of the penis as needed.

Next, the urethral plate is grasped on either side with 0.5 forceps (Figure 4.19) and then incised in the midline using tenotomy scissors (Figure 4.20). The incision continues to near the underlying corpora cavernosa and into the native urethra proximally.

A 6-F polyurethane (Kendall) catheter is passed into the bladder in prepubertal boys and secured to the glans stay suture (Figure 4.21). Urethral plate tubularization is then performed in two layers with running subepithelial 7-0 polyglactin on a TG 140-8 needle. The most distal stitch should be at least 3 mm from the tip of the urethral plate to avoid iatrogenic meatal stenosis, with the resulting meatus oval in shape.

A flap is then created from the preserved ventral dartos and flipped up to cover the neourethra (Figure

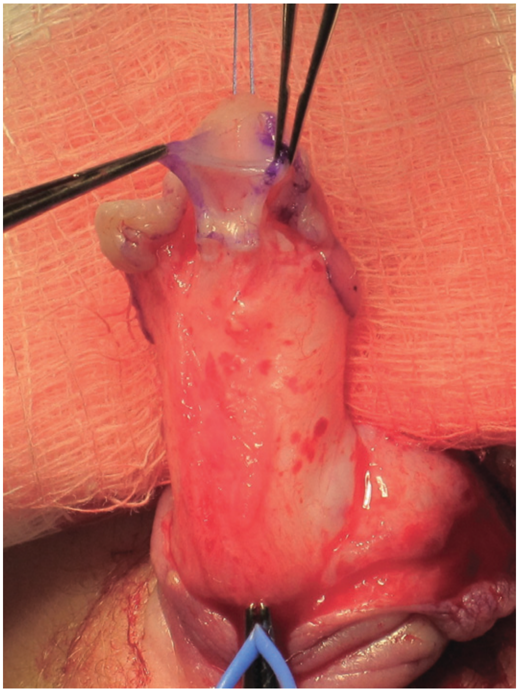

Figure 4.19 After dissection of the glans wings, the urethral plate is held symmetrically apart with 0.5 forceps and incised in the midline.

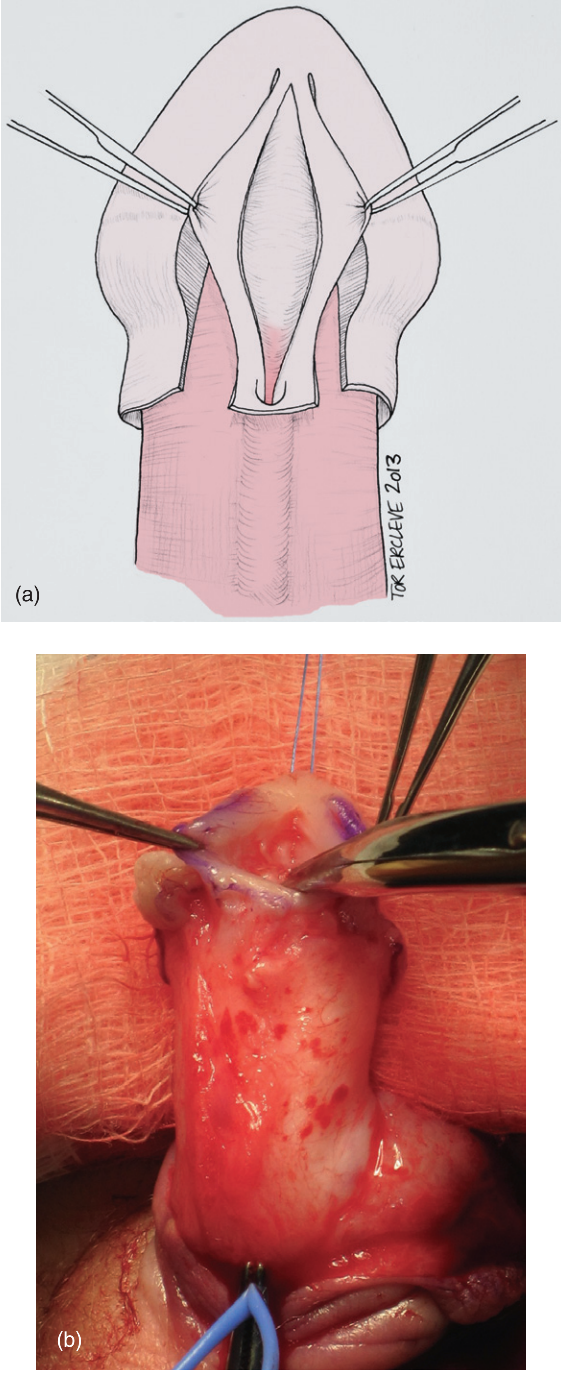

Figure 4.20 (a) Illustration and (b) intraoperative picture depicting the appearance after midline incision of the urethral plate. (Source: (a) Tor Ercleve. Reproduced with permission of Tor Ercleve.)

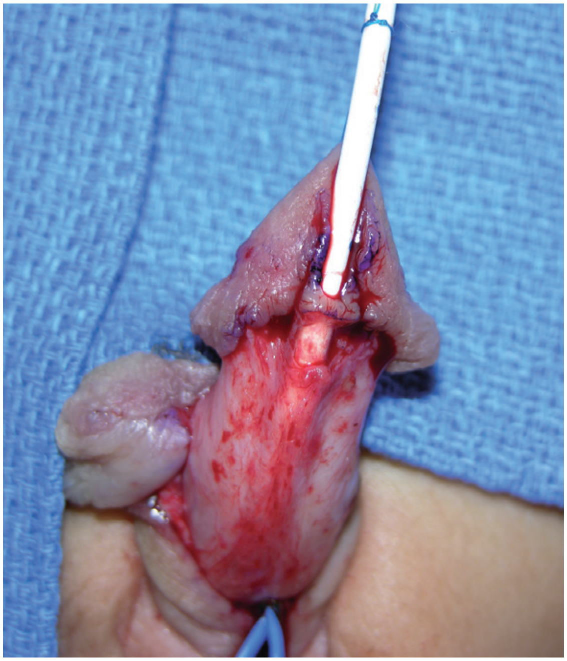

Figure 4.21 A 6-F polyurethane stent is secured into place with the previously placed polypropylene stitch. Urethroplasty is performed in two layers with a running subepithelial 7-0 polyglactin closure on a TG 140-8 needle.

4.22a). If there is insufficient ventral dartos, a dorsal dartos flap is created and either brought around the side, avoiding torsion, or buttonholed to cover the neourethra (Figure 4.22b), anchoring it in place with 7-0 polyglactin sutures.

Glansplasty is independent of the underlying urethroplasty, meaning that the glans wings are not sutured to the neourethra. The distal stitch approximates the glans wings at the point that visually corresponds to the correct location for the ventral lip of the meatus (Figure 4.23). Additional subepithelial interrupted sutures continue to the corona, using 6-0 polyglactin for a total of approximately three stitches. The skin edges are not sutured to avoid suture tracks.

The inner preputial collar is then approximated, after excising the midline shaft skin (Figure 4.24a), with interrupted subcuticular 7-0 polyglactin (Figure 4.24b). Then a vertical incision is made in the dorsal foreskin hood to the mucosal collar at the 12 o'clock position (Figure 4.25a) and the shaft skin is sewn to the inner prepuce with a subcuticular 7-0 polyglactin (Figure 4.25b). Skin is rotated ventrally as needed to cover the ventral surface and create a median raphe, excising excess skin to complete the circumcision (Figure 4.26). All skin closures are performed using interrupted subcuticular 7-0 polyglactin.

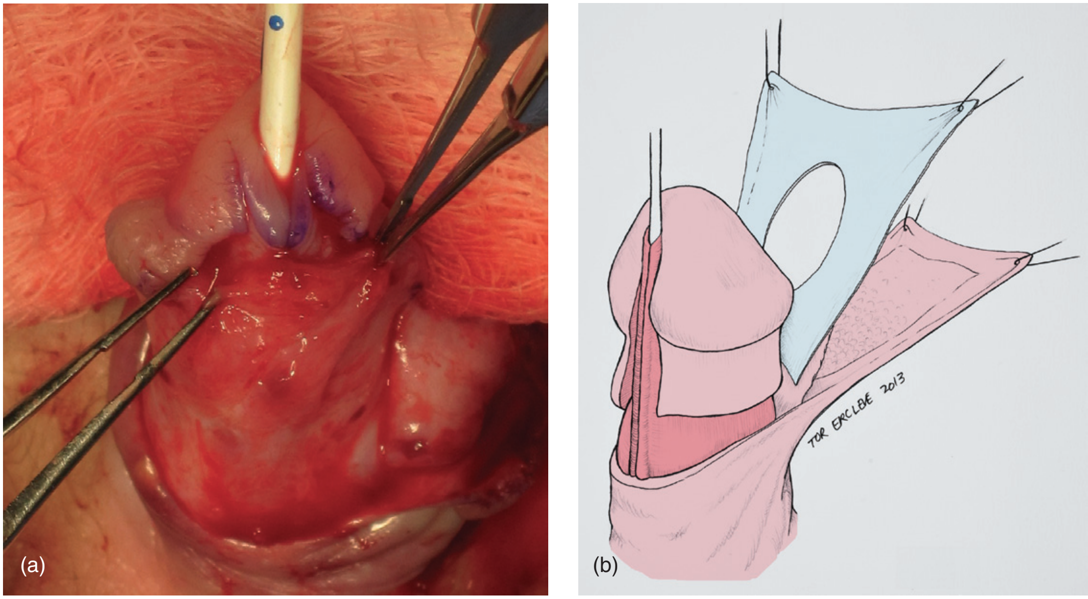

Figure 4.22 (a) A ventral dartos flap has been harvested and will be secured to either side of the neourethra with interrupted 7-0 polyglactin. (b) If insufficient ventral dartos is available to cover the neourethra without tension, a dorsal dartos flap is created and brought to the ventral surface via a buttonhole and secured into place with interrupted 7-0 polyglactin. (Source: (b) Tor Ercleve. Reproduced with permission of Tor Ercleve.)

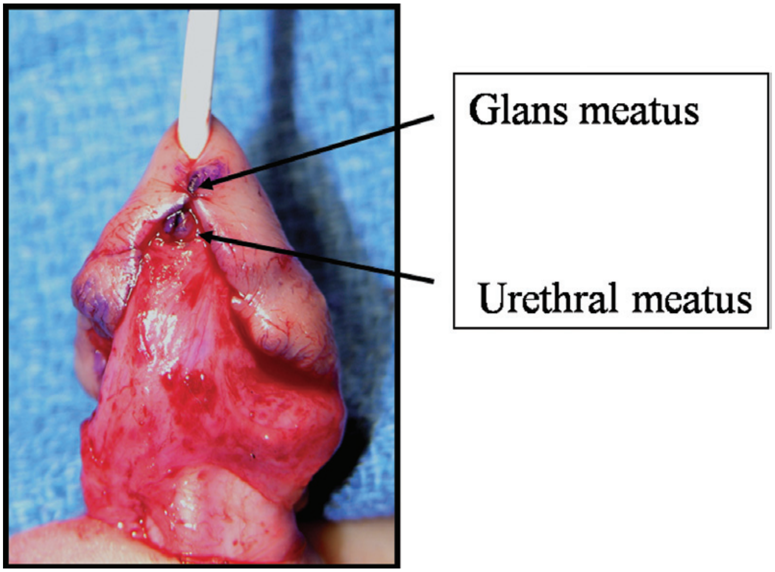

Figure 4.23 The distal stitch of the glans wings approximation is placed through epithelium at the point that visually corresponds to the correct location for the ventral lip of the meatus using 7-0 polyglactin and is not secured to the underlying neourethra. Two or three single-layer subepithelial 6-0 polyglactin interrupted stitches complete the glansplasty.

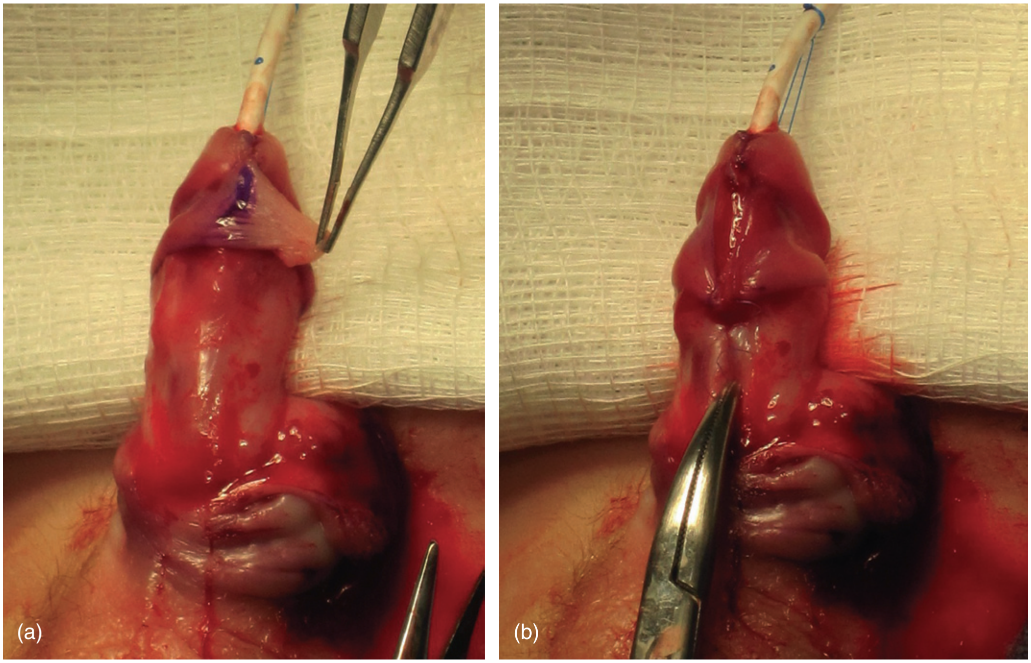

Figure 4.24 For boys desiring hypospadias repair with circumcision, the Firlit skirt skin flaps are brought to the ventral surface and an excess triangular portion of skin is excised after marking the appropriate location on each side (purple surgical mark, (a)). The edges are then reapproximated using 7-0 polyglactin in a subcuticular interrupted fashion (b). When a small gap occurs that cannot be reapproximated with a subcuticular stitch, we use a 9-0 polyglactin through the skin near the corona.

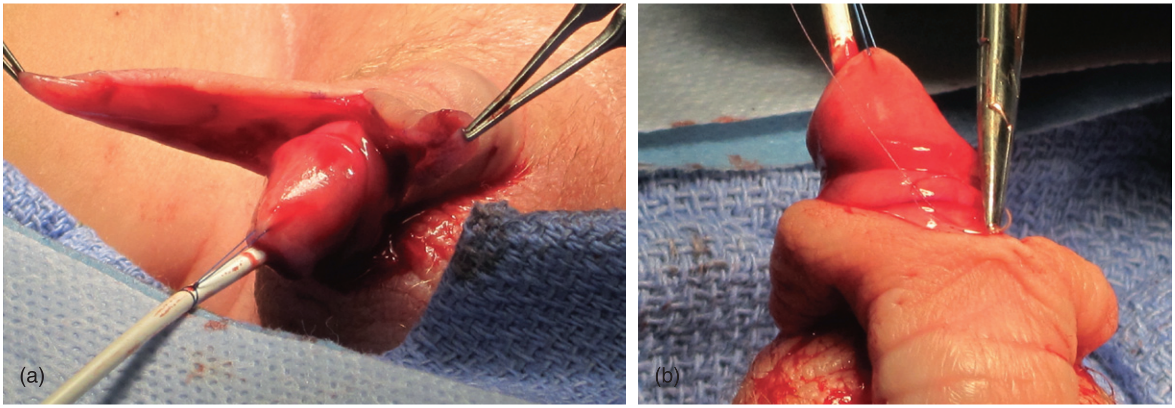

Figure 4.25 In order to complete the circumcision, excess inner preputial and shaft skin is divided in the dorsal midline along the 12 o'clock position to the level of the mucosal collar (a) and secured into place using an interrupted 7-0 polyglactin subcuticular suture (b).

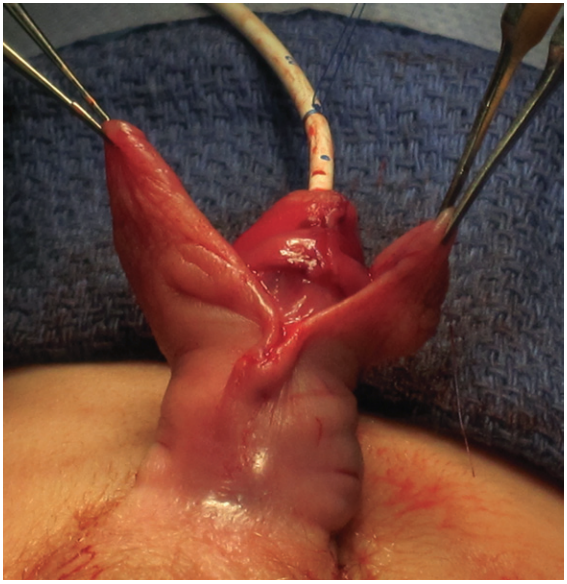

Figure 4.26 A ridge of skin to mimic the appearance of the median raphe is created using subcuticular interrupted 7-0 polyglactin.

Postoperative dressings

The penile dressing reduces postoperative hematoma and edema. The penis is wrapped with a transparent dressing (Tegaderm), then gently compressed with another transparent dressing placed over a gauze. The urethral stent is removed approximately 7 days after surgery in distal repairs, and 2 mg/kg co-trimoxazole is given twice daily while the stent is in place. Boys younger than 2 years receive ibuprofen and acetaminophen for pain relief, while boys older than 2 are also prescribed hydrocodone. Boys older than 3 years receive oxybutynin 0.2 mg/kg twice daily.

Distal repair with preservation of foreskin (preputioplasty)

A glans stitch is placed as described above, along with additional stay sutures in the edges of the incomplete prepuce as shown (Figure 4.27). A U-shaped incision is marked to below the hypospadiac meatus, and then injected with 1:100,000 U/mL epinephrine with lidocaine prior to incision. Dissection, which is limited to the ventral aspect of the penis (Figure 4.28), is performed immediately under the skin to preserve the ventral dartos which can be used as a barrier flap.

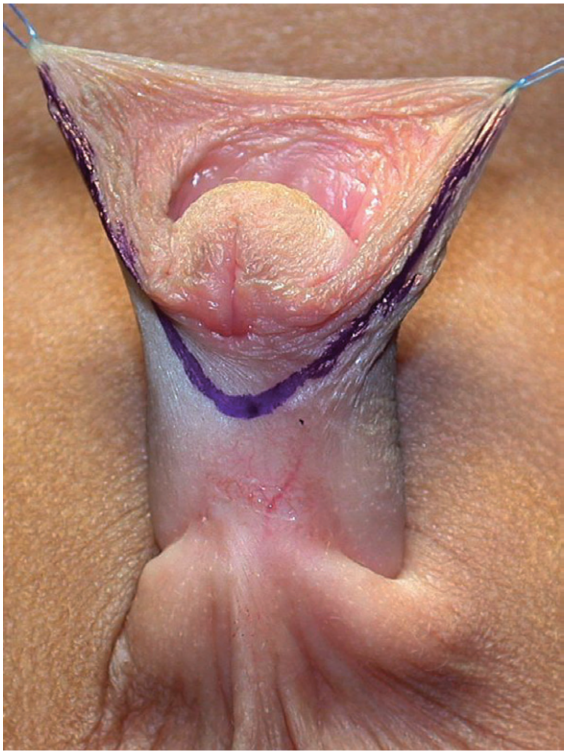

Figure 4.27 In TIP repair with foreskin reconstruction, a U-shaped incision is marked and incised from the corners of the prepuce to below the hypospadiac meatus. Only ventral dissection is performed, extending the incision along the median raphe and midline scrotum as needed for additional exposure.

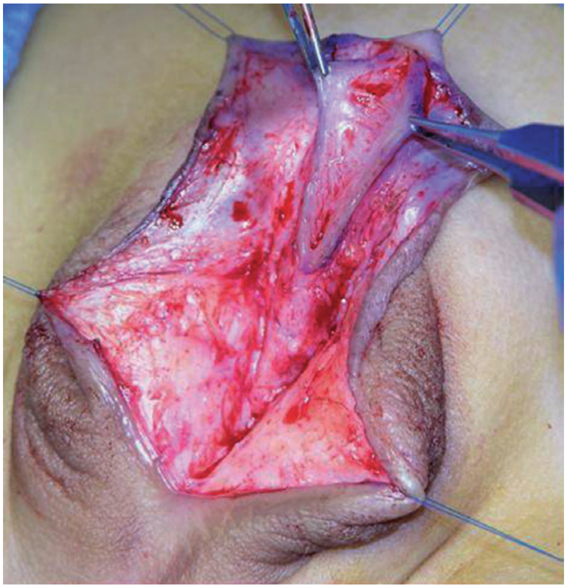

Figure 4.28 Appearance after incision of the urethral plate in a patient undergoing foreskin-preserving hypospadias repair.

Urethroplasty and glansplasty are performed as described above. The ventral dartos provides a barrier flap over the neourethra, but when there is insufficient dartos no barrier layer is used.

Preputioplasty begins with the inner surface, approximated with subepithelial interrupted 7-0 polyglactin. The skin is then reduced over the glans and additional interrupted stitches are placed to reinforce the inner layer closure. Finally, the outer surface is approximated, beginning with the distal corners after ensuring closure does not restrict retraction over the glans. If the foreskin is too tight and not retractable, this distal stitch is removed and replaced slightly more proximally, with closure completed using 7-0 polyglactin interrupted subcuticular stitches. Any gap between the first distal stitch and the end of the prepuce is closed via a Heineke–Mikulicz maneuver. The postoperative appearance is shown in Figure 4.29.

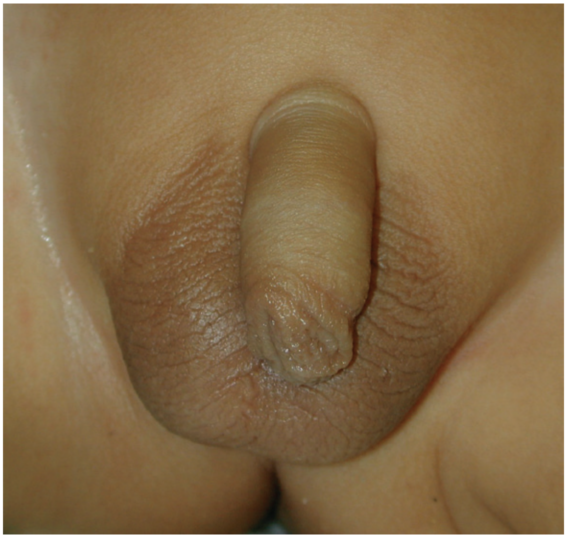

Figure 4.29 Postoperative results of distal hypospadias repair with foreskin reconstruction.

Proximal hypospadias

Intraoperative decision-making is determined by the extent of the ventral curvature. Using the algorithm discussed below, there is either no curvature, or curvature is straightened preserving the urethral plate in 75% of patients with proximal hypospadias, leading to TIP urethroplasty. In the 25% who do require plate transection for straightening, we prefer a two-stage graft using the prepuce in patients undergoing circumcision and lower lip mucosa in patients desiring foreskin reconstruction.

Surgical technique

A ventral "U" is marked along the visible border of the urethral plate (Figure 4.30) and injected with 1 : 100,000 U/mL epinephrine with lidocaine to minimize bleeding from the corpus spongiosum, which is often immediately under the shaft skin. Either circumcision or foreskin reconstruction can be performed as described above for distal hypospadias repair.

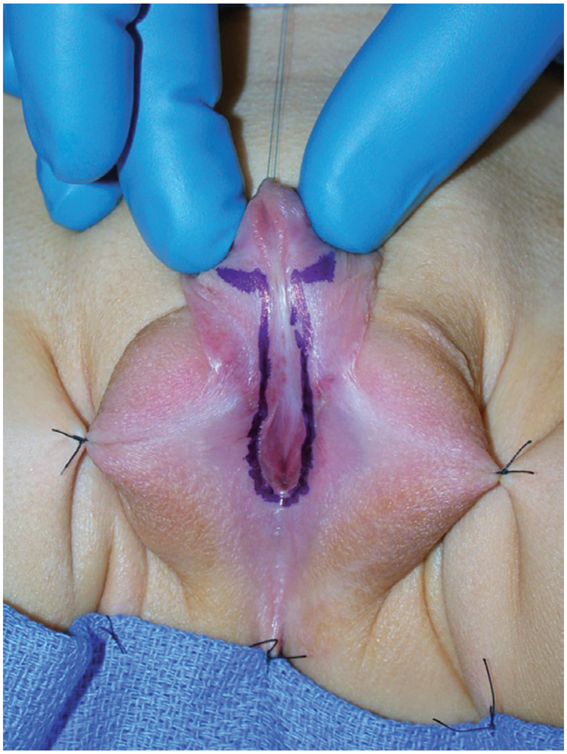

Figure 4.30 The purple incision lines are marked for the repair of proximal hypospadias. The incision is extended to the corners of the hooded prepuce for those undergoing foreskin reconstruction, or along the preputial collar ventrally as shown in Figure 4.17(b) for those desiring circumcision.

After skin dissection, the glans wings are developed to either side of the urethral plate as described above for distal hypospadias repair. The wings of the corpus spongiosum along the lateral border of the urethral plate are freed from the underlying corpora cavernosa and their fusion with the glans wings is released before the artificial erection is performed. If the curvature is more than 30°, dissection of the spongiosum continues under the urethral plate to completely elevate it from the corpora cavernosa, then continuing the mobilization proximally to include the proximal normal urethra up to the level of the membranous urethra. This maneuver uses the natural elasticity of the urethra and urethral plate in order to achieve penile straightening without transecting the plate in most cases (Figure 4.31). If the artificial erection now demonstrates ventral curvature less than 30°, a single dorsal plication is performed with 6-0 polypropylene [7]. For curvature more than 30°, ventral lengthening is achieved by three separate transverse corporotomy incisions in the area of greatest bending, made several millimeters apart (Figure 4.32) and extending from 4 to 8 o'clock just through the tunica albuginea of the corpora cavernosa. Grafting over these incisions is not performed. We supplement ventral lengthening with a single midline dorsal plication stitch because artificial erection is less reliable after ventral corporal incision. If the penile curvature remains more than 30° after all of these steps, the urethral plate is transected.

When the urethral plate is maintained, it is incised in the midline, taking care to avoid dividing it into two separate strips when it has been elevated from the corpora (Figure 4.33). Tubularization is performed over a 6-F polyurethane stent in two layers, first using subepithelial interrupted 7-0 polyglactin, followed by continuous 7-0 polydioxanone. Spongioplasty approximates the corpus spongiosum over the neourethra with 7-0

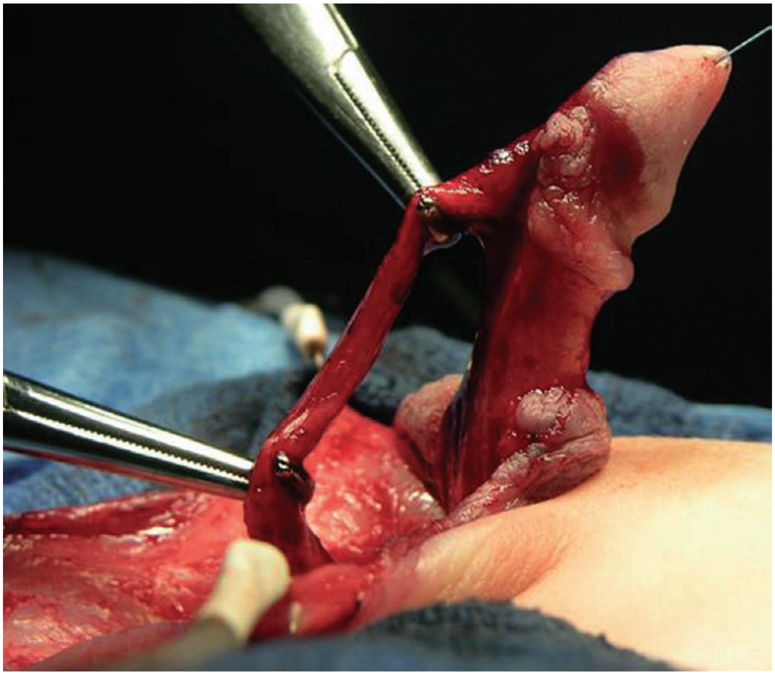

Figure 4.31 For persistent ventral curvature of more than 30° despite dissecting the urethral plate from the underlying corpora cavernosa, dissection of the normally formed urethra to the level of the membranous urethra is performed followed by a repeat artificial erection.

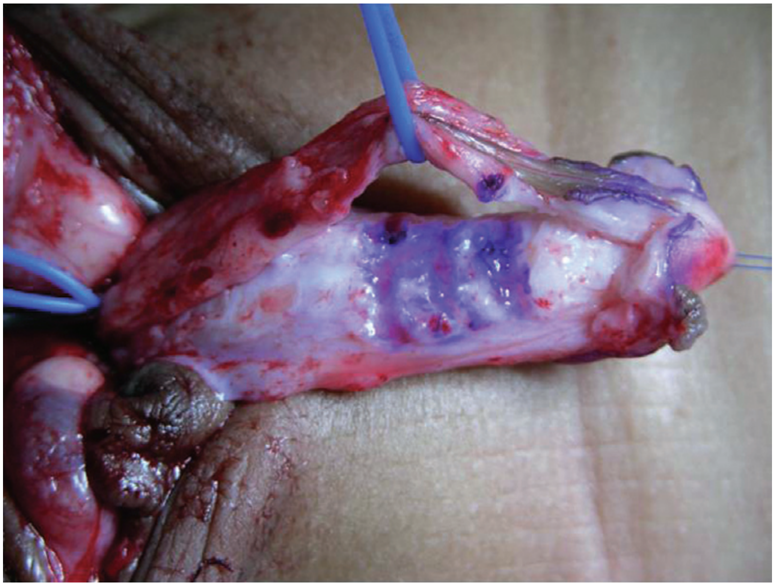

Figure 4.32 When a ventral curvature greater than 30° remains despite urethral and urethral plate dissection, three transverse corporotomies are made superficially into the tunica albuginea from approximately 4 o'clock to 8 o'clock, supplemented by a single midline dorsal plication.

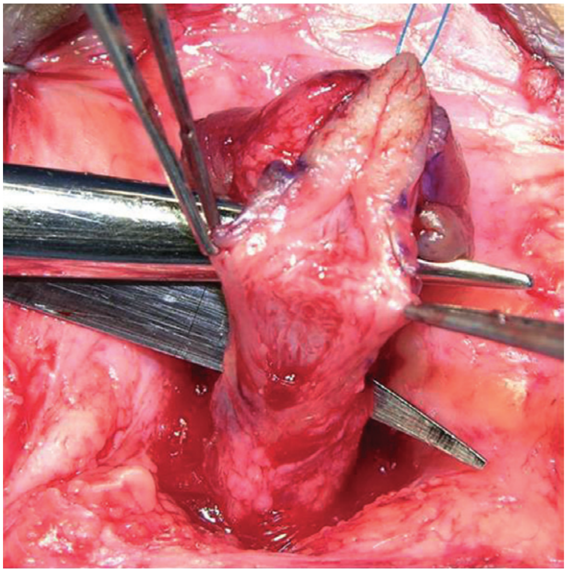

Figure 4.33 The urethral plate is incised in the midline, taking care to avoid dividing it into two separate strips following elevation of the corpora.

polydioxanone. A tunica vaginalis (TV) flap is then harvested: the testicle is delivered from the scrotum and the flap is dissected to the level of the external ring to decrease the risk of testicular elevation or traction on the penis with erection (Figure 4.34). The testicle is then secured back into a normal position using a standard orchidopexy technique. The TV flap covers the entire neourethra, anchored with interrupted 7-0 polydiaxanone, with the epithelial surface placed down over the suture line.

Glansplasty is performed as described above using interrupted subepithelial 6-0 polyglactin. As in distal repairs, the glans is not sutured to the underlying neourethra. Then, either circumcision or foreskin repair is carried out as previously described. In all patients, ventral shaft skin is secured to the corpora cavernosa to either side of the TV flap using subepithelial 5-0 polydioxanone to establish the penoscrotal junction.

The stent is left in place for 14 days with dressing and medication regimens identical to those with distal hypospadias. Postoperative follow-up is scheduled at 6 weeks, 6 months and then annually.

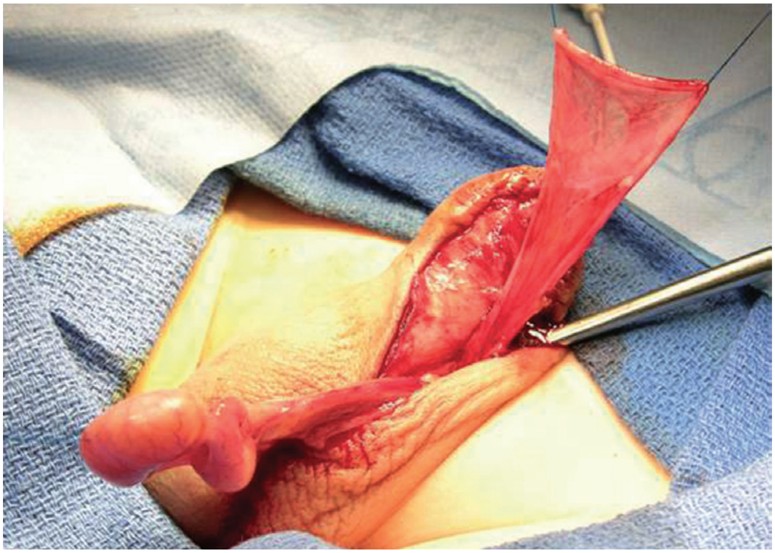

Figure 4.34 To harvest the tunica vaginalis flap, the testis is delivered from the scrotum and the flap is dissected to the level of the external ring. It is then used to cover the entire neourethra and secured into place using interrupted 7-0 polyglactin.

Epispadias

Epispadias can occur as part of the extrophy–epispadias complex or it may present as a simple epispadias associated with a glanular urethral opening on the dorsum of the penis and a competent bladder neck. The erect penis is deviated dorsally because of the short dorsal urethral plate and the dorsal curvature. Multiple procedures may be required to reconstruct the penis.

Surgical technique

We perform complete penile disassembly for epispadias repair, closing the skin with a rotational skin flap to avoid a dorsal midline scar. Traction stitches are placed into each hemiglans with 5-0 polypropylene. A U-shaped incision is made along the margins of the dorsal urethral plate (Figure 4.35) and continued ventrally around the inner prepuce to deglove the skin. The urethral plate is next completely dissected from the glans and underlying corporal bodies. Next the hemiglans and corpora are separated from each other in the midline, dividing the penis into three separate structures: urethral plate and two corpora/glans (Figure 4.36). The urethral plate is tubularized over a 6-F stent using 7-0 polyglactin interrupted subepithelial stitches as the first layer and a running 7-0 polydioxanone for the second. The neourethra is then moved ventrally as the corpora are rotated dorsally and reapproximated with interrupted 5-0 polydiaxanone stitches, avoiding the neurovascular bundles. Next the dorsal aspects of the hemiglans are approximated with interrupted subepithelial 6-0 polyglactin to the distal point for the neomeatus. The urethra is stretched distally to this point and sutured using interrupted subepithelial 7-0 polyglactin. However, complete disassembly often lengthens the penis such that the urethra will not reach the correct glans position. In these circumstances, the urethra is sutured as a cutaneous urethrostomy on to the ventral aspect of the penis, and a graft from the prepuce or lip mucosa is placed distally for a second stage urethroplasty after 6 months.

Next the shaft skin is released, maintaining its ventral vascular pedicle, by a circumferential incision at the penopubic–penoscrotal junction. This creates a skin flap that can be rotated around the dorsum and then reapproximated ventrally in a median raphe (Figure 4.37). The early postoperative appearance using a rotated skin flap closure is demonstrated in Figure 4.38. The stent is maintained for 14 days. Dressings and postoperative care are as described above for hypospadias surgery.

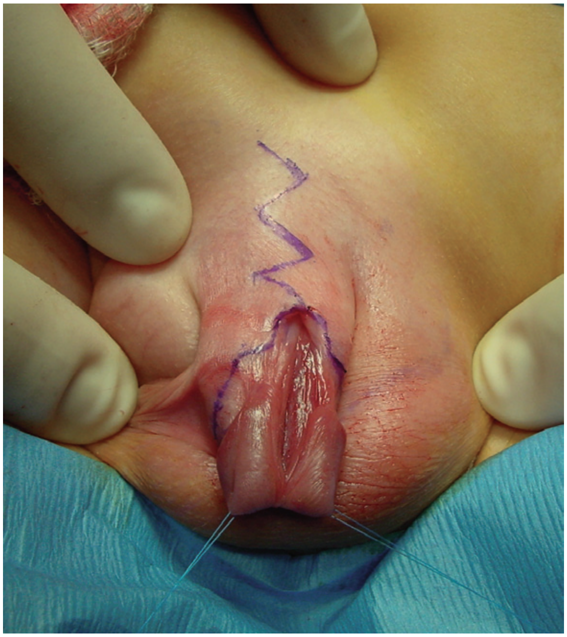

Figure 4.35 The initial incision lines for repair of epispadias are marked. A Z-shaped incision of the suprapubic area is performed, extending along the 12 o'clock position and extending circumferentially around the penis. After degloving, the rectangular flap of penile shaft skin will be rotated along its pedicle and reapproximated ventrally in order to avoid a dorsal suture line. (Reproduced with permission from J. Pippi Salle.)

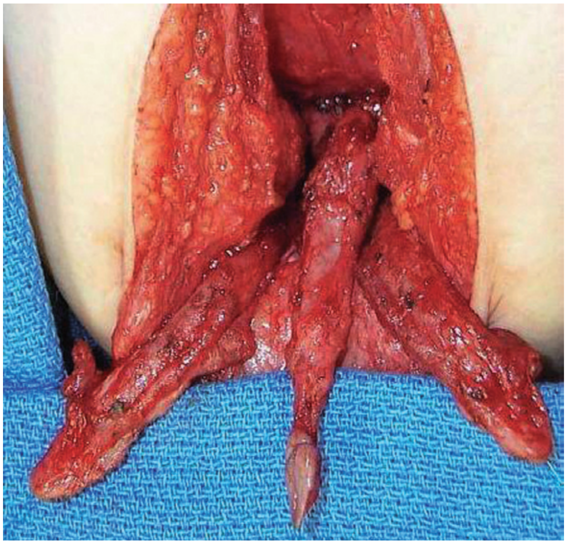

Figure 4.36 Shallow incisions on either side of the urethral plate are made after injection with 1 : 100,000 U/mL epinephrine. Dissection frees the urethral plate and spongiosum from each corporal body, separating them into three components.

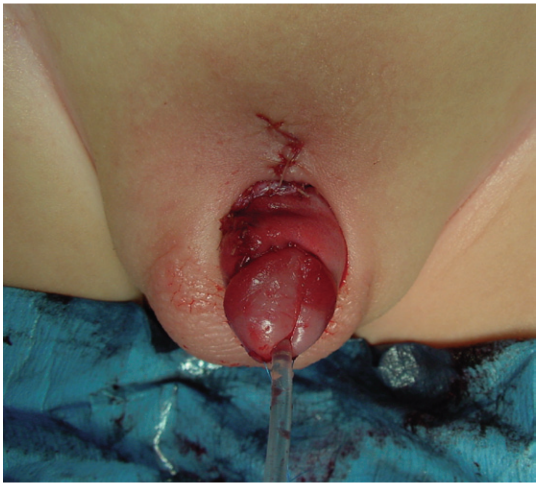

Figure 4.37 A penile skin flap has been rotated 90°, tacked with 5-0 polydioxanone at the penopubic and penoscrotal junctions, and secured proximally and distally with subcuticular 7-0 polyglactin. Closure of the skin at the dorsal 12 o'clock position is avoided. (Reproduced with permission from J. Pippi Salle.)

Key tips for the surgeon

Each of the anomalies described above can be surgically corrected with few complications. Both good cosmetic as well as functional results can be achieved using the meticulous, methodical techniques as illustrated. The incidence of fistulas is reduced by two-layer subepithelial urethroplasties covered with barrier flaps, while meatal stenosis is avoided by not closing the urethral plate too far distally. All scars should be concealed in the ventral median raphe or in the junction of the inner prepuce and shaft skin following circumcision.

Acknowledgments

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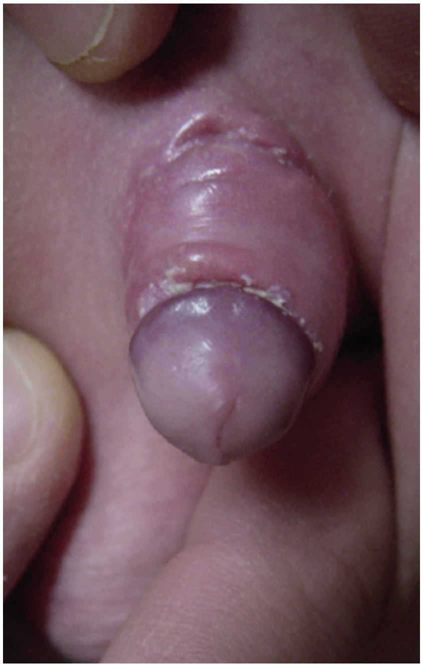

Figure 4.38 The early postoperative appearance using a rotated skin flap closure during epispadias repair is demonstrated. (Reproduced with permission from J. Pippi Salle.)

References

1 Horowitz M, Gershbein AB. Gomco circumcision: When is it safe? J Pediatr Surg 2001;36(7):1047–9.

2 Yang CC, Bradley WE. Innervation of the human glans penis. J Urol 1999;161(1):97–102.

3 Weksler N, Atias I, Klein M, Rosenztsveig V, Ovadia L, Gurman GM. Is penile block better than caudal epidural block for postcircumcision analgesia? J Anesth 2005;19(1):36–9.

4 Kaye JD, Kalisvaart JF, Cuda SP, Elmore JM, Cerwinka WH, Kirsch AJ. Sutureless and scalpel-free circumcision: More rapid, less expensive and better? J Urol 2010;184(4 Suppl):1758–62.

5 Wahlin N. "Triple incision plasty". A convenient procedure for preputial relief. Scand J Urol Nephrol 1992;26(2):107–10.

6 Fischer-Klein C, Rauchenwald M. Triple incision to treat phimosis in children: an alternative to circumcision? BJU Int 2003;92(4):459–62; discussion 62.

7 Baskin LS, Duckett JW. Dorsal tunica albuginea plication for hypospadias curvature. J Urol 1994;151(6):1668–71.

8 Fisher C, Park M. Penile torsion repair using dorsal dartos flap rotation. J Urol 2004;171(5):1903–4.

9 Firlit CF. The mucosal collar in hypospadias surgery. J Urol 1987;137(1):80–2.

5

Surgical Management of Cryptorchidism and Testicular Tumors

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Pediatric inguinal orchidopexy

The undescended testicle is the most common congenital anomaly of the male genitalia, affecting up to 4% of boys at birth. The incidence falls to 1% at 1 year of age, most probably related to the postnatal surge of testosterone causing further descent of testicles that have not fully descended at birth.

The undescended testicle should be classified as either palpable (80%) or impalpable (20%) as this has important clinical implications in terms of further investigations and surgical management. Any child with bilateral impalpable gonads or a unilateral impalpable gonad and hypospadias should be referred immediately to a specialist for the investigation of a possible disorder of sex development (DSD).

Clinical features

Careful clinical examination is the mainstay of making the diagnosis. Radiologic examinations such as ultrasound and magnetic resonance imaging (MRI) scans are rarely helpful and do not necessarily alter the surgical management.

An undescended testicle can generally be palpated in the region of the external inguinal ring, in a region commonly termed the "superficial inguinal pouch." It can be manipulated to varying distances into the scrotum, with the spermatic cord feeling taut with the testicle on traction. When the testicle is released it characteristically springs back to its original location or even further into the inguinal canal. A retractile testicle behaves differently in that when it is released it maintains its position in the scrotum for a brief period of time before slowly retracting to a more proximal position because of an exaggerated cremasteric reflex. In addition, a retractile testicle can be brought into the base of the scrotum, with minimal tension in the spermatic cord.

If despite careful examination the testicle cannot be felt, then this would indicate that the testicle may be within the inguinal canal, intra-abdominal or even absent. Hypertrophy of the contralateral testicle is sometimes suggestive of a unilateral absent testicle.

Surgical management

The timing for orchidopexy remains a controversial topic but there is universal agreement that the testicle should be brought into the scrotum by 18 months of age. A testicle that remains in an undescended location at 6–9 months of age is highly unlikely to descend any further and orchidopexy should be considered. Boys with unilateral or bilateral impalpable testicles will require examination under anesthesia and diagnostic laparoscopy. This should be performed ideally at 9–12 months of age, allowing adequate time for a two-stage orchidopexy should this be required.

Surgical risks

Mobilization of the spermatic cord may cause inadvertent damage to the cord structures. Parents should be

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warned specifically of the following risks and complications associated with the procedure:

1 Damage to the vas deferens;
2 Postoperative testicular atrophy;
3 Wound infection;
4 Postoperative bleeding and/or scrotal hematoma; and
5 Recurrence.

Prognosis

Following orchidopexy, the affected testicle is often slightly smaller and higher in the scrotum than the unaffected testicle. It is well reported that fertility may be compromised in men who have a history of undescended testicles, although how this may affect long-term paternity still remains unclear. It is reported that the risk of testicular cancer is increased 10-fold in the affected testicle, with 10% of men with testicular cancer having previously undergone an orchidopexy.

Patient preparation

Inguinal orchidopexy is performed under general anesthesia with the patient in the supine position. Regional analgesia by means of a caudal block or ilioinguinal block is recommended before starting the procedure. The ipsilateral groin, the penis and the entire scrotum are prepared with antiseptic and these areas are kept exposed when the surgical drapes are applied.

Surgical technique

1 An incision, 2–3 cm in length is made in the groin crease in the region overlying the spermatic cord (Figure 5.1). The spermatic cord can be palpated superior and lateral to the pubic tubercle. The incision is deepened with blunt dissection to expose Scarpa's fascia, which is divided with monopolar diathermy. The testicle is located in the superficial inguinal pouch, grasped with toothed forceps and brought out through the wound. Using bipolar diathermy, the gubernaculum is divided and the cremasteric muscle and fascia is cleared to expose the spermatic cord as it exits the external inguinal ring. The anterior wall of the inguinal canal can be opened extending from the external inguinal ring for a distance of 1–2 cm if additional exposure of the spermatic cord is required.

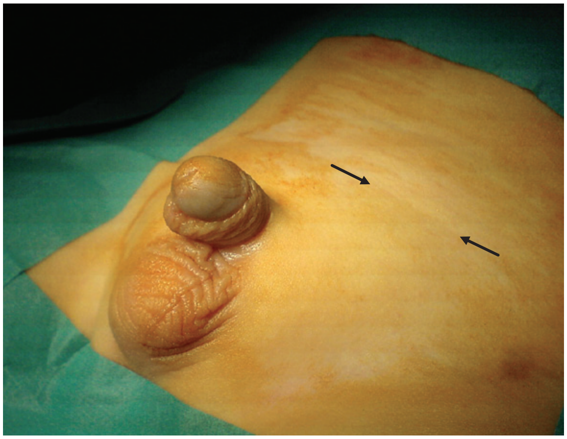

Figure 5.1 The groin and scrotum are prepared with antiseptic. A 2–3 cm incision is made in the groin crease overlying the external inguinal ring.

2 The hernial sac is carefully separated from the vas and testicular vessels either using blunt dissection or sharp iris scissors to divide across the hernial sac in a circumferential manner (Figure 5.2).

3 Once isolated, the hernial sac is separated from the vas and testicular vessels moving proximally towards the internal inguinal ring. In this manner, the vas and testicular vessels are released creating adequate length to bring the testis into a suitable position in the scrotum. The proximal divided end of the hernial sac is transfixed and ligated with an absorbable suture (Figure 5.3).

4 A 1-cm transverse incision is made in the ipsilateral scrotum, and a subdartos pouch is created with iris scissors with the tip of the index finger placed inside the scrotum via the inguinal incision (Figure 5.4).

5 A closed artery forceps is placed onto the tip of the index finger and advanced in a retrograde manner into the inguinal incision. The testicle is grasped on its surface with the artery forceps and brought down through the scrotal incision. The testicle is then placed in the subdartos pouch. Only if there is tension on the vas and testicular vessels should the testicle be secured to the median raphe with a single absorbable suture (Figure 5.5).

6 The wounds are closed in layers with absorbable interrupted sutures to the inguinal canal (if opened), Scarpa's fascia and the subcutaneous fat. The skin is closed with a subcuticular absorbable suture (Figure 5.6).

Postoperative care

The child can be discharged home on the same day as surgery. Routine oral analgesia (acetaminophen and ibuprofen) should be given on a regular basis for the first 48 hours and as required thereafter. The parents should be advised to prevent the child from engaging in activities that involve straddling, such as cycling, for a period of 4 weeks.

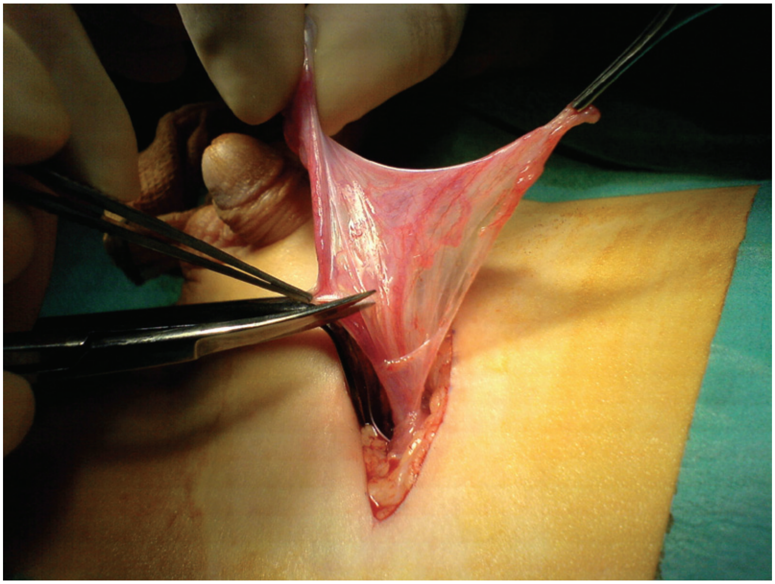

Figure 5.2 The hernial sac is separated from the underlying vas and testicular vessels. This allows additional mobilization of the cord structures in order to reduce the tension on the testicle once mobilized into the scrotum.

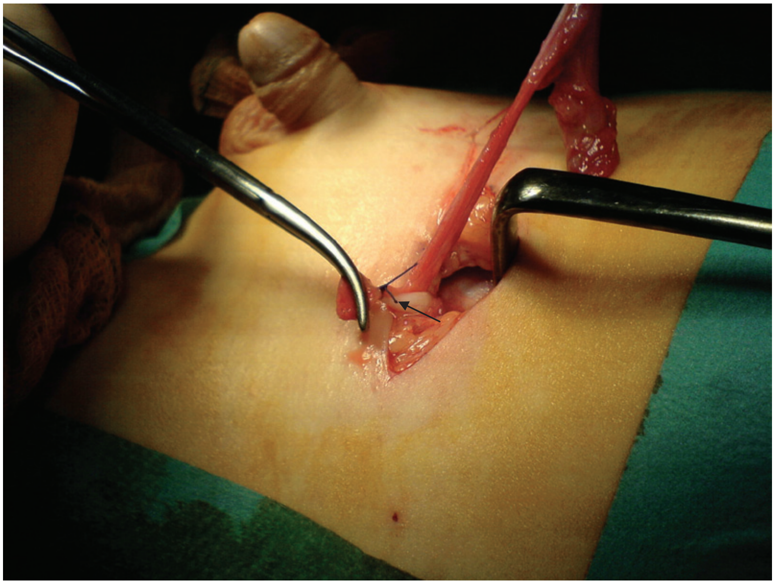

Figure 5.3 The isolated hernial sac is divided and transfixed proximally. Black arrow shows the hernial sac transfixed.

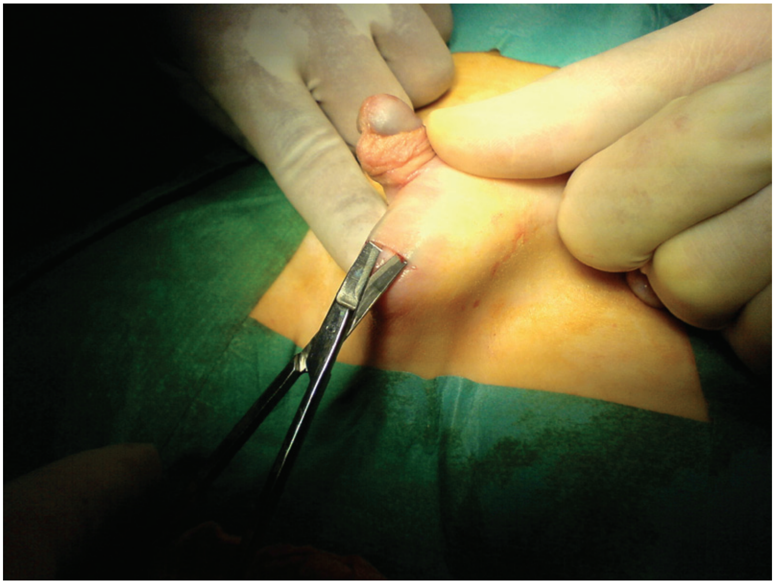

Figure 5.4 Incision in the hemiscrotum is followed by creation of a subdartos pouch.

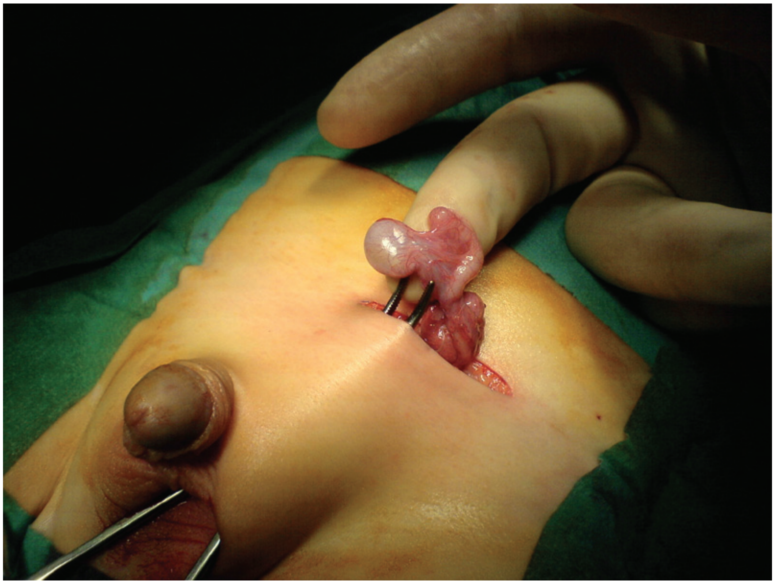

Figure 5.5 The testicle is drawn down into the scrotum with an artery forceps.

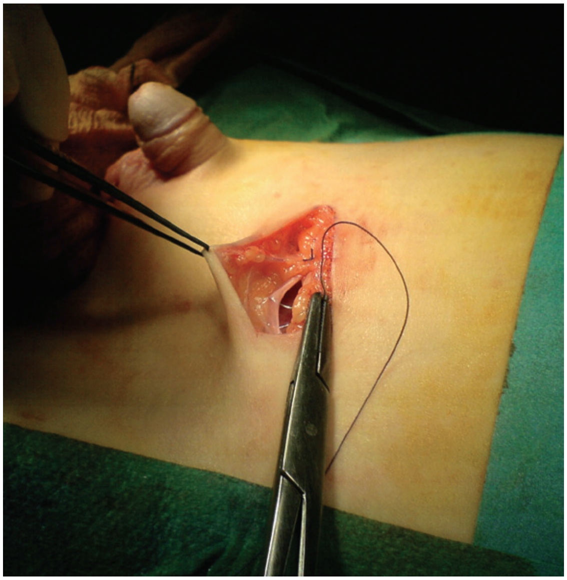

Figure 5.6 Closure of Scarpa's fascia.

Management of intra-abdominal testicles

Radiologic imaging techniques such as MRI and ultrasonography remain unreliable in locating impalpable testicles. Laparoscopy allows the visualization of the internal ring as well as the pelvis and paracolic gutters. This allows the surgeon to visualize the testicle within the abdomen and relocate the testicle into the scrotum.

Surgical management

Laparoscopy may reveal a closed internal ring with the vessels and vas entering the inguinal canal. In this scenario exploration of the inguinal canal and a conventional inguinal orchidopexy is required. If there is a closed ring with blind ending vessels then the testicle is deemed absent. If a testicle is present then laparoscopic mobilization of the testicular vessels in order to gain enough length and allow the testicle to be relocated in the scrotum can be performed (Figure 5.7).

Surgical risks

Apart from the general risks associated with laparoscopic procedures, which include bowel and vascular injuries and port site hernias, specific risks include testicular atrophy or loss of the testicle. The procedure to relocate the testicle into the scrotum may require a staged procedure depending on the length of the testicular vessels.

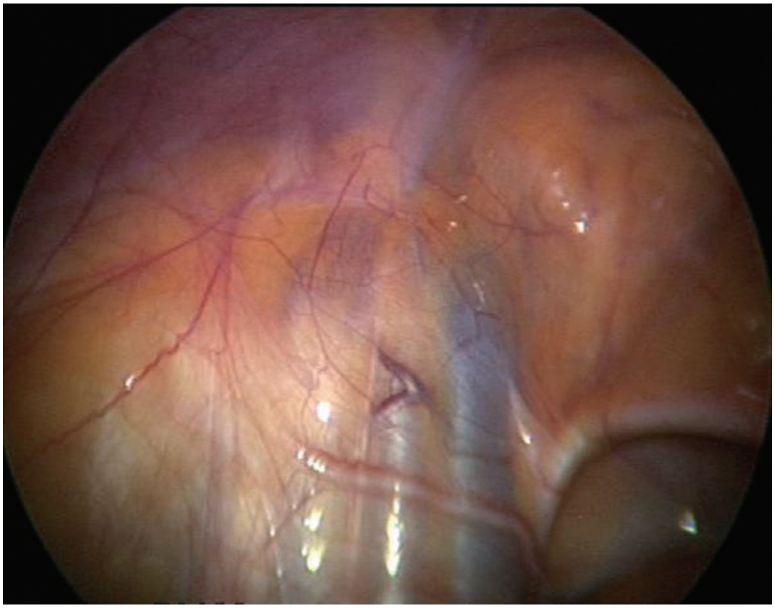

Figure 5.7 Diagnostic laparoscopy demonstrating an absent testis with a blind ending vas. (Left side.)

The risk of testicular loss with a two-stage Fowler–Stephens procedure is 20%.

Patient preparation

The procedure is performed under general anesthetic as either a conventional laparoscopic procedure or a da Vinci robot-assisted procedure. Three ports are normally sufficient with the camera port at the umbilicus (Figure 5.8). The patient is placed supine with a 10–30° Trendelenburg position allowing the bowel to fall away.

Surgical technique

The testicle can lie anywhere between the internal ring and the kidney. Once localized a retroperitoneal dissection of the testicular vessels is performed and this can be extended to the origin of the testicular vessels at the renal hilum. An adequate length is achieved when the testicle can be manipulated to the contralateral internal ring. If this is not possible then a Fowler–Stephens approach is required. If there is adequate length then the testicle is manipulated through the internal ring and into the scrotum where a dartos pouch is created. If a hernia is also present then this can be closed laparoscopically.

If a first-stage Fowler–Stephens procedure is required then the testicular vessels are ligated and the vas is not mobilized (Figure 5.9a). The testicle survives on the artery to the vas which is a branch of the inferior vesical artery. The second stage is performed 6 months later.

The second stage of a Fowler–Stephens procedure starts with a peritoneal incision at least 1 cm lateral to the testicular vessels (Figure 5.9b). A triangular flap of peritoneum is incised around the vas and internal ring with the apex extending to the pelvic vas (Figure 5.10). A new canal can then be created between the medial umbilical ligament and ipsilateral inferior epigastric artery in the “triangle of safe exit” (Figures 5.11, 5.12, 5.13, 5.14, 5.15, 5.16 and 5.17). The bladder should

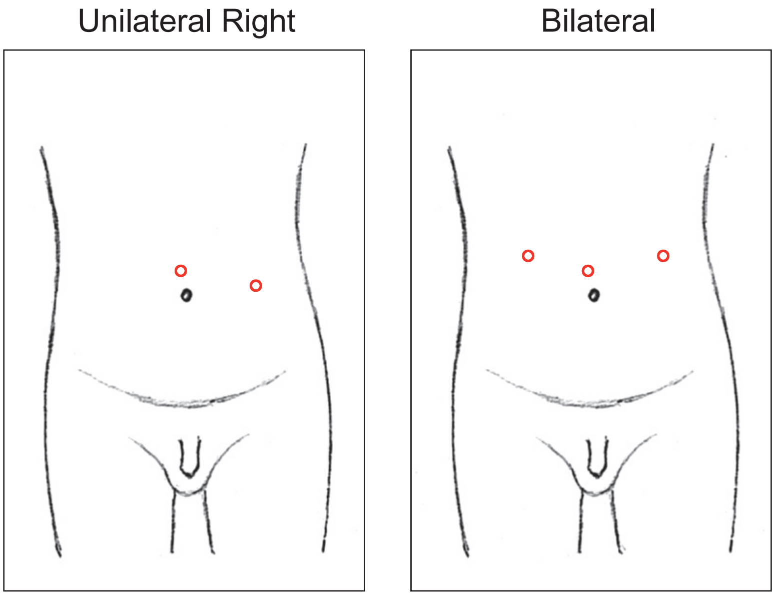

Figure 5.8 Port placement for unilateral and bilateral procedures with camera port placed at the umbilicus.

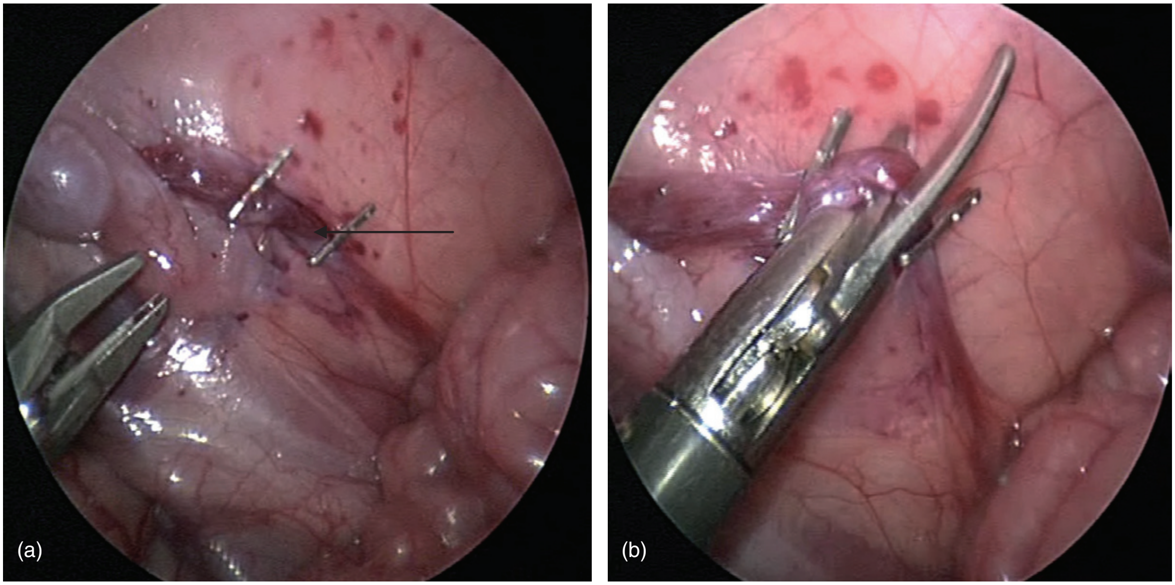

Figure 5.9 (a) The testicular vessels (black arrow) are identified and mobilized. Clips are used to ligate the testicular vessels. (b) The testicular vessels are divided using endoscopic scissors between the clips. (Right side.)

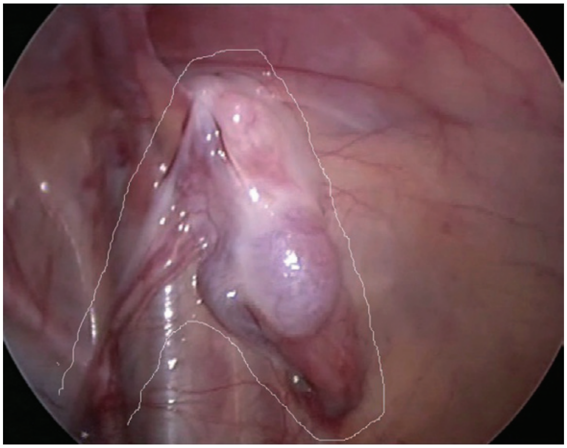

Figure 5.10 The outline for the triangle of peritoneum to be incised is illustrated. A wide peritoneal pedicle over the vas deferens allows preservation of the blood supply when mobilizing the vas deferens. (Procedure demonstrated for right testicle.)

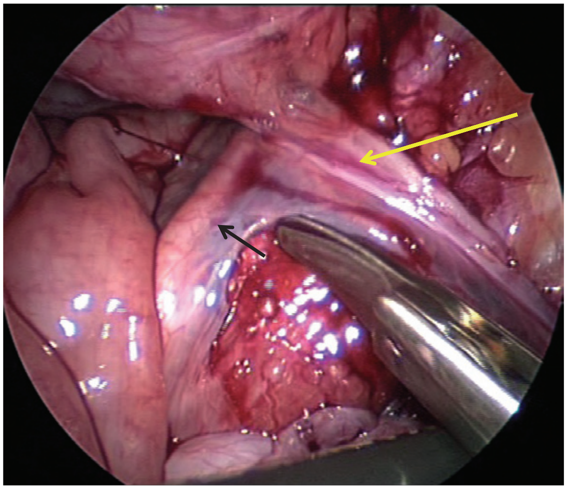

Figure 5.11 The triangular flap of peritoneum is incised with endoscopic scissors ensuring that a large peritoneal pedicle (yellow arrow) is mobilized with the vas deferens in order to preserve the collateral blood supply. Further mobilization of the testicle and testicular vessels to the level of the ureter (black arrow) is performed. This ensures that there is adequate length to allow a tension-free placement into the scrotum.

remain empty to avoid inadvertent injury to the bladder when creating a new canal. A curved clamp can then be passed through the scrotum and over the pubic bone to enter the new canal allowing the testicle to be gently grasped and placed into a dartos pouch. While the laparoscope is still in the abdomen, the vas should be visualized to ensure that it lies medially and the testicular vessels have not been rotated.

In rare cases where there is a solitary high intra-abdominal testicle, failure to gain enough length is not possible. In these circumstances a microvascular testicular autotransplantation can be performed by anastomosing the testicular vessels to the inferior epigastric artery and vein.

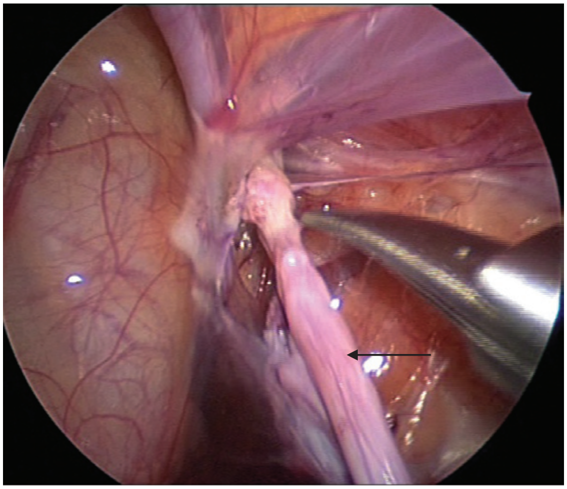

Figure 5.12 The gubernaculum (black arrow) is identified and dissected as far down into the internal ring as is possible in order to preserve the collateral blood supply. The gubernaculum is then divided.

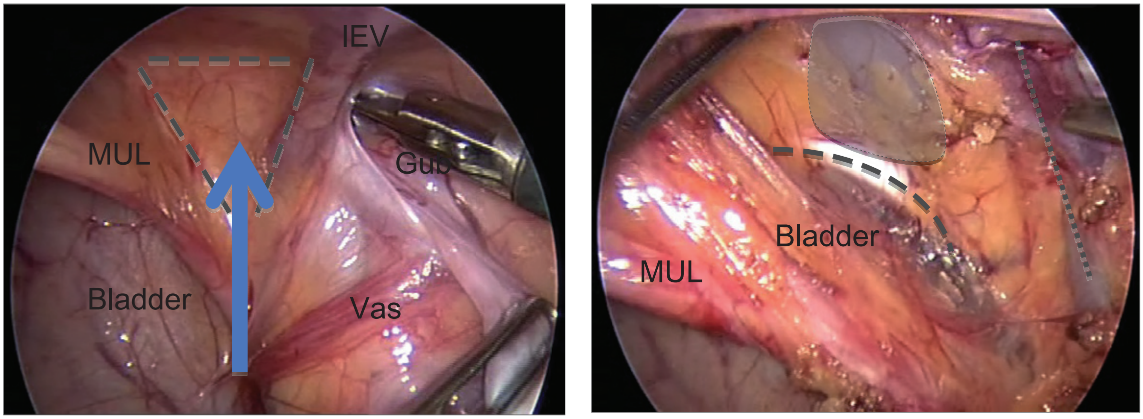

Figure 5.13 Anatomic landmarks for rerouting the testicle and testicular vessels medial to the inferior epigastric vessels and lateral to the medial umbilical ligament. “Triangle of safe exit” shown for the right testicle (blue arrow). Gub, gubernaculum; IEV, inferior epigastric vessels; MUL, medial umbilical ligament.

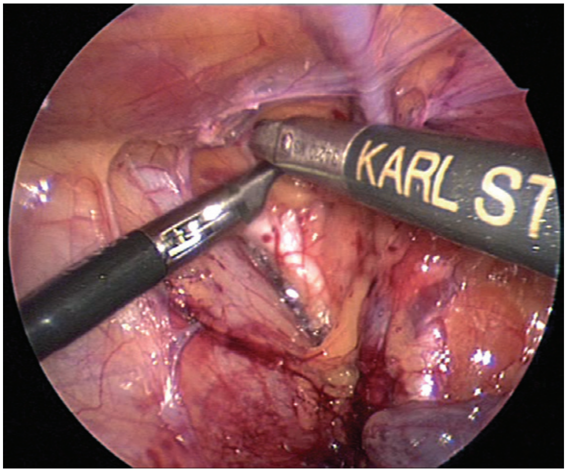

Figure 5.14 Dissection between the medial umbilical ligament and inferior epigastric vessels is performed to create a new canal. This allows rerouting of the testicular vessels and testicle into the scrotum via a new and shorter canal.

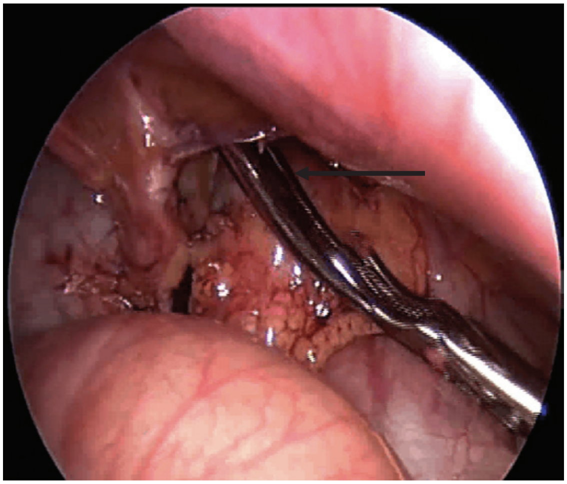

Figure 5.15 A curved clamp (black arrow) is passed under direct vision through the scrotum and over the pubic bone by using an endoscopic instrument through the "triangle of safe exit." The new canal is then gently dilated. The lower pole of the testicle can now be grasped and the testicle is gently manipulated into the scrotum.

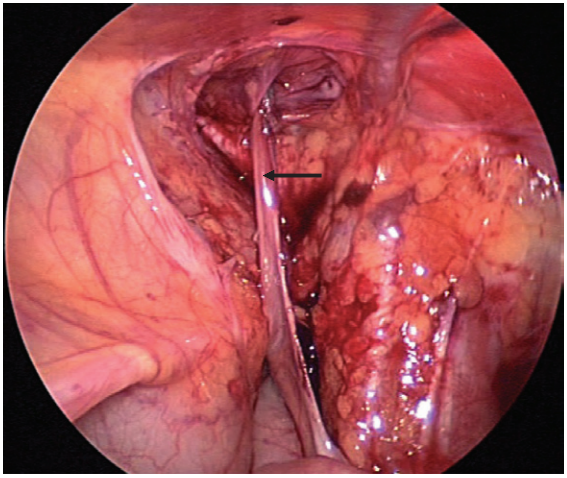

Figure 5.16 View of the testicular vessels (black arrow) entering the new canal between the medial umbilical ligament and inferior epigastric vessels. Before removing the laparoscopic ports, the intra-abdominal pressure is reduced to ensure hemostasis.

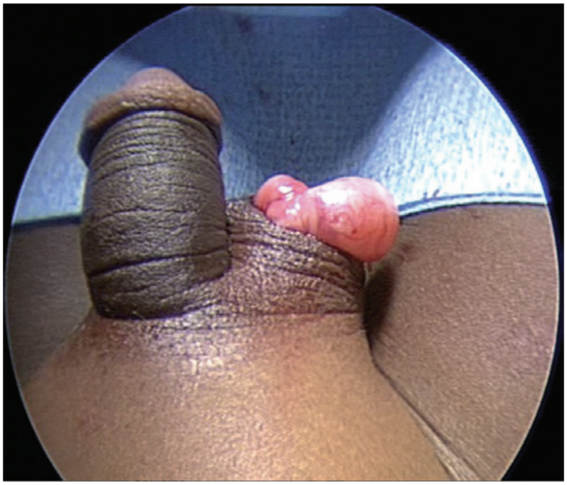

Figure 5.17 The testicle is brought out of the scrotum and fixed in a dartos pouch as described in Figure 5.4.

Inguinal orchidectomy

Pediatric testicular tumors account for only 1–2% of all pediatric tumors. They are classified broadly into germ cell tumors (yolk sac tumor, teratoma) and nongerm cell tumors (Leydig cell tumor, Sertoli cell tumor, gonadoblastoma).

Clinical features

The majority of patients with testicular tumors present with a painless scrotal mass. The differential diagnosis includes hydrocele, hernia, epididymitis and delayed testicular torsion. Once a testicular tumor is suspected a thorough physical examination should be carried out, looking for signs of androgenization and evidence of metastatic disease.

Investigations

Initial radiologic investigations include a testicular and abdominal ultrasound with a chest X-ray. Once the diagnosis has been confirmed a CT and/or MRI is performed to stage the tumor. Serum testicular tumor markers are also checked preoperatively (α-fetoprotein, β human chorionic gonadotropin and lactic dehydrogenase).

Surgical risks

Patients should be warned about:

1 Scrotal and retroperitoneal hematoma formation;
2 Wound infection;
3 Ilioinguinal nerve injury; and
4 Hernia

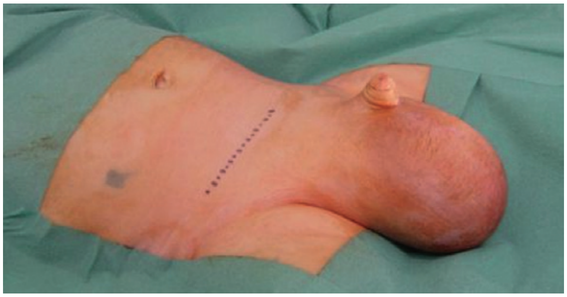

Figure 5.18 The surgical incision should allow easy delivery of the testicular tumor. A generous incision, 3–5 cm in length is made in the groin crease in the region overlying the spermatic cord.

Surgical management

The surgical management of testicular tumors is initially to perform an inguinal orchidectomy. Increasing consideration is being given to testis-sparing surgery but this is only a possibility in prepubertal children where a benign tumor is suspected.

Patient preparation

Inguinal orchidectomy is performed under general anesthesia with the patient in the supine position. Regional analgesia by means of a caudal block or ilioinguinal block is recommended. The ipsilateral groin, the penis and the entire scrotum are prepared with antiseptic and these areas are kept exposed when the surgical drapes are applied (Figure 5.18).

Surgical technique

The spermatic cord is elevated and a noncrushing clamp is applied to the cord at the level of the internal inguinal ring (Figures 5.19, 5.20, 5.21, 5.22 and 5.23). The testicle is delivered into the wound and the gubernaculum is divided with bipolar diathermy (Figures 5.24, 5.25 and 5.26).

In cases where a benign tumor is suspected, testis-sparing surgery can be performed using ultrasound guidance to locate the lesion (Figures 5.27 and 5.28).

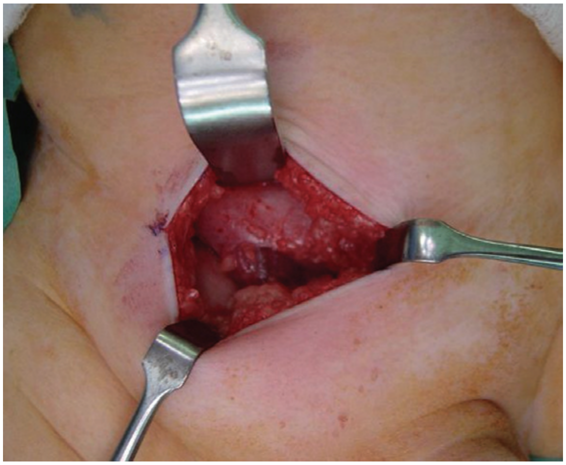

Figure 5.19 The incision is deepened with blunt dissection to expose Scarpa's fascia, which is divided with monopolar diathermy. The full length of the inguinal canal is displayed.

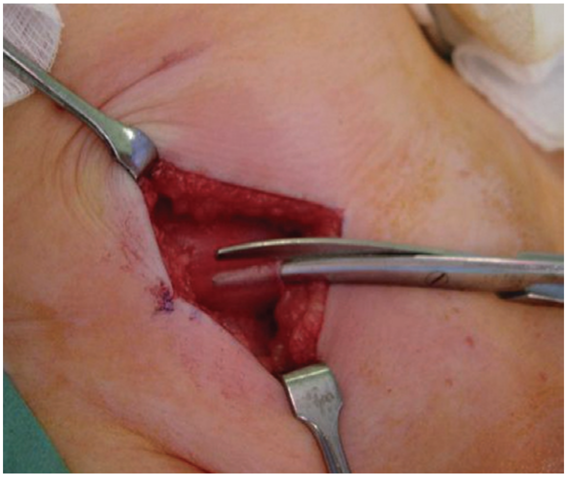

Figure 5.20 The external oblique aponeurosis is divided in the line of its fibers from the superficial inguinal ring.

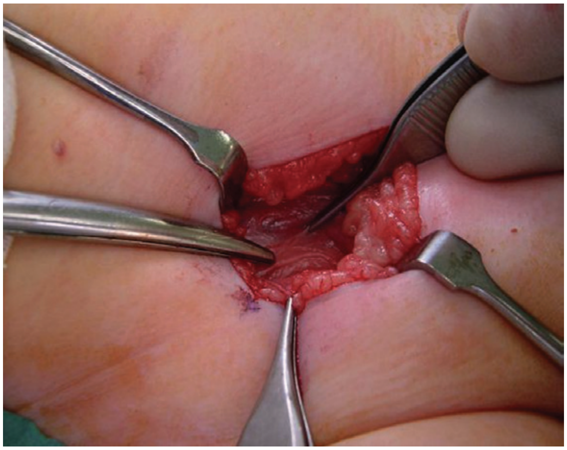

Figure 5.21 The ilioinguinal and genital branch of the genitofemoral nerve are protected.

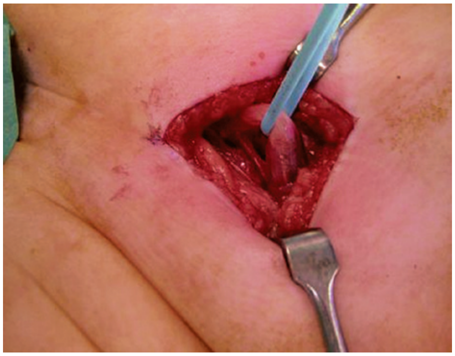

Figure 5.22 The spermatic cord is elevated and the cremasteric fibers are bluntly dissected from the cord.

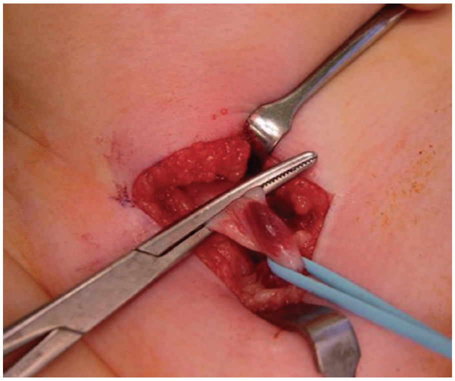

Figure 5.23 A clamp is applied to the proximal end of the spermatic cord at the level of the deep inguinal ring.

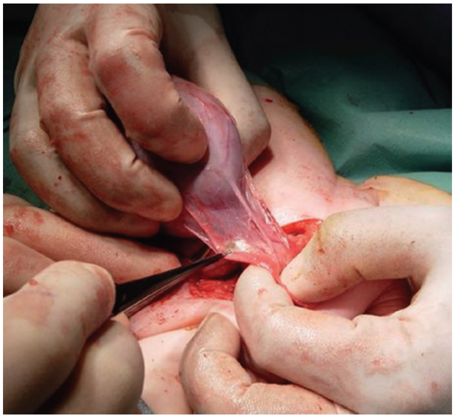

Figure 5.24 The testicle is delivered out of the inguinal wound and the gubernaculum is divided.

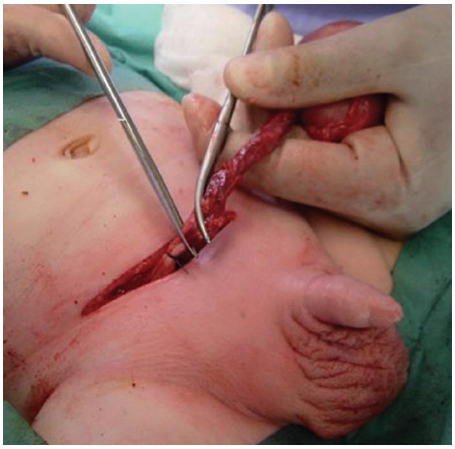

Figure 5.25 The testicle is palpated in order to confirm the testicular mass and the spermatic cord proximal to the noncrushing clamp is divided between artery forceps. The proximal stump of the cord is transfixed with an absorbable suture. The specimen is sent for histologic examination.

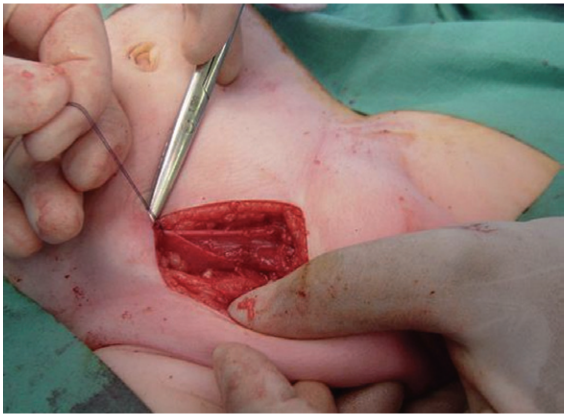

Figure 5.26 The wound is closed in layers with absorbable interrupted sutures to the inguinal canal, Scarpa's fascia and the subcutaneous fat using the same technique as for inguinal orchidopexy described above. The skin is closed with a subcuticular absorbable suture.

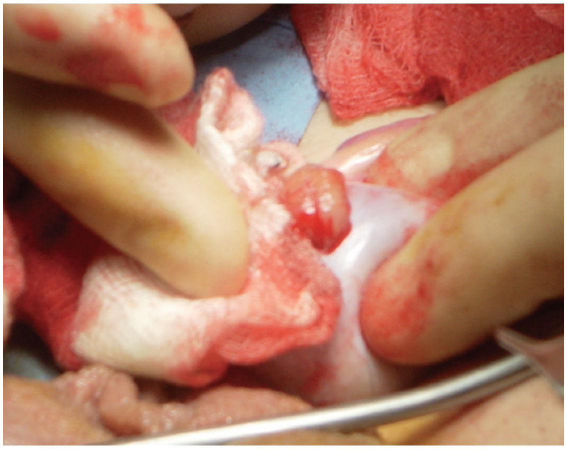

Figure 5.28 The tunica albuginea is incised. The lesion is enucleated and biopsies from the adjacent areas are taken. The lesion together with the biopsies are sent for frozen section analysis. If these are benign the testicle can be preserved. Closure of the tunica albuginea is performed using 4-0 polyglactin suture.

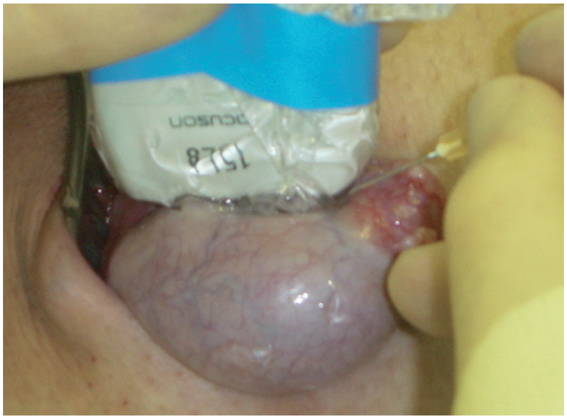

Figure 5.27 Testis preserving surgery requires the use of intraoperative ultrasound. The testicle is delivered through an inguinal incision. An ultrasound is performed to locate the indeterminate lesion. A needle is placed into the lesion.

Postoperative care

Following an orchidectomy the child should be kept in hospital overnight to provide adequate pain relief and to monitor for scrotal swelling and hematoma formation. Further management is dictated by the histology and the presence or absence of metastatic disease. A testicular prosthesis can be inserted in older children either at the time of radical inguinal orchidectomy or delayed until the child is well beyond puberty. The testicular prosthesis is available in small, medium or large sizes and is inserted into the scrotal sac via the same inguinal incision. A small flange can either be sutured to the dartos muscle in the scrotum or alternatively the testicle can be manually manipulated by gently pulling down on the prosthesis until it lies in the most dependent position.

6

Surgery for Penile Curvature

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Introduction

Penile curvature can be caused by a congenital chordee (also termed congenital curvature), or it may be an acquired deformity as a result of Peyronie's disease. Although the surgical treatment for congenital chordee is similar to that performed for mild to moderate Peyronie's disease, it is a different clinical entity. Typically, congenital chordee, which has an estimated prevalence of 0.6%, is identified with the penis in the erect state. These men typically have a ventral curvature. However, lateral and dorsal congenital curvatures can also occur. Curvature associated with hypospadias should not be termed a congenital chordee but called a hypospadias. Peyronie's disease, on the other hand, is now considered to be a wound-healing disorder which results in a palpable scar involving the tunica albuginea of the corpora cavernosa. Research has suggested that the scarring does not undergo resolution because of a downregulation or dysfunction of the typical collagenases involved in remodeling, and/or because those collagenases are being blocked by excessive levels of tissue inhibitors of metalloproteinases (TIMPs) [1].

Regardless, the outcome can be both a physically and psychologically devastating problem for the affected male. The etiology and pathophysiology of Peyronie's disease are still not well understood. It is thought to occur as a result of trauma to the erect or flaccid penis, but personal experience has suggested that up to 80% of men presenting with Peyronie's disease will not have recognized a distinct trauma to their penis. Another theory proposes that microvascular trauma resulting in a subtunical bleed can result in aberrant wound healing due to increased synthesis of collagen, proteoglycans and fibronectin mediated by transforming growth factor β_1 (TGF-β_1).

The precise pathophysiology of congenital chordee is also not well understood but appears to be caused by a disproportion in the amount or elasticity of the tunica on one aspect of the penis compared to the contralateral aspect. Therefore if the dorsal aspect of the penis has more tissue and/or elasticity it will result in a ventral bend in the erect state. There is no palpable irregularity in the tunica and the penis usually has excellent elasticity and is characteristically longer than the average adult stretched penile length. Usually, pain is not associated with congenital chordee but the deformity can interfere with sexual activity and may cause cosmetic distress. Finally, if the curvature is severe, this can interfere with vaginal penetration, making coitus difficult or in some cases impossible.

Clinical features

The clinical presentation of Peyronie's disease includes a palpable plaque which is a misnomer for a scar that is made primarily of type I and III collagen. As a result of the distribution of the scarring, shortening and indentation of the penis may occur. Circumferential scarring may result in a hinge effect, as well as a curvature in virtually any direction. The majority of men present with a dorsal or dorsolateral curvature. The extent of the curvature varies and patients who only have a minor curvature (<30°) may find that the deformity does not interfere with sexual activity. In these circumstances no treatment is necessary. However, if the deformity causes patient

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distress or interferes with sexual function resulting in patient or partner discomfort, then treatment is indicated. Current treatment options include nonsurgical and surgical approaches. Of note, there is at this time no US Food and Drug Administration (FDA) approved nonsurgical treatment for Peyronie's disease in spite of many approaches that have been used since the time of de La Peyronie in the mid 1700s [2]. Surgical treatment will be discussed in greater detail in the subsequent sections.

Peyronie's disease may also be associated with pain at initial presentation, which appears to be due to an inflammatory reaction during the active phase of the disease. Typically, the active phase will resolve within 6–12 months and is followed by a chronic phase which is normally pain free and the penile curvature is stable. As a result, the recommendations for surgery are not to proceed until at least 1 year from the onset of the disease and when there has been at least 6 months with a stable penile deformity.

Assessment

Assessment of the patient presenting with penile curvature whether it be due to congenital chordee or Peyronie's disease is essentially the same. The penis should be examined in detail. Gentle palpation is best performed with the penis on stretch. In particular the septum is carefully palpated as virtually all Peyronie's plaques involve the septum either dorsally and/or ventrally. A plaque may develop as a nodule or a cord-like structure. In the acute phase it may be painful to touch and/or cause pain with erection or during attempts at intercourse. An extremely hard plaque may be an indication of plaque calcification and can occur in up to 30% of patients with Peyronie's disease. Historically, plaque calcification has been thought to be an indication of a mature plaque. It is now felt that calcification represents a separate subtype of Peyronie's disease. In the patient with congenital chordee there is no palpable plaque, although occasionally tunical thickening may occur.

The stretched penile length is measured by grasping the glans with the patient supine and pulling it perpendicular to the body. The stretched length can then be measured by pressing down on the pubis with a rigid ruler and measuring either to the corona dorsally or to the urethral meatus (Figure 6.1). The authors' preference is to measure to the corona, as the pubis and corona are two reliable fixed features. Further assessment includes penile duplex Doppler ultrasound. The value of this study in the patient with Peyronie's disease is to identify the presence of plaque calcification or corporal fibrosis, as well as providing an assessment of penile arterial blood flow and veno-occlusive dysfunction following vasoactive intracavernosal injection [3]. Finally, the penis can be examined for quality of rigidity as well as deformity. Curvature is best measured with a goniometer, and girth can be assessed with a string placed at the base, subcoronal area and areas of indentation (Figure 6.2). The patient with congenital chordee may benefit from a duplex ultrasound to assess the severity of the curvature, but by and large the surgical approach for congenital chordee is tunical plication.

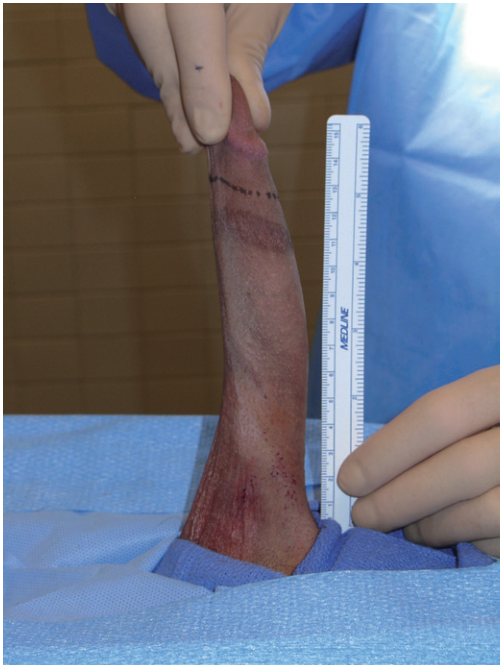

Figure 6.1 Before starting the procedure the length of the penis is measured and documented on stretch from the pubis to the corona dorsally.

The foreskin is assessed for any evidence of lichen sclerosus or phimosis. A completely normal foreskin can be left intact provided that the patient is aware of the risk of paraphimosis or persistent edema of the distal preputial cuff. However, patients with an abnormal foreskin are circumcised at the time of corrective surgery.

Biothesiometry, a measure of vibratory sensation, has been considered to be the least invasive method to evaluate penile sexual sensation indirectly. Vibration is delivered with a fixed frequency, variable attenuation device.

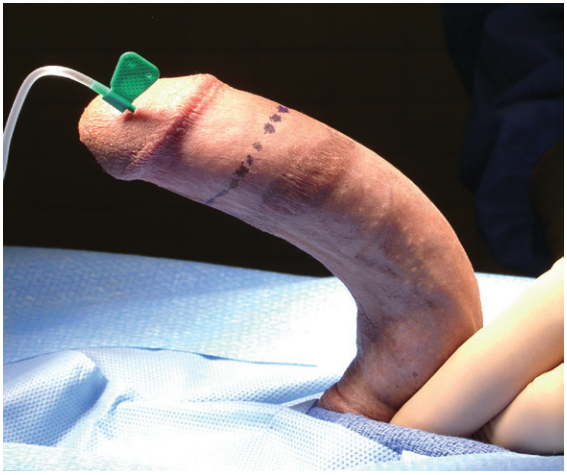

Figure 6.2 The penile curvature is demonstrated following an artificial erection induced by injecting 60 mg papaverine through a 21-gauge butterfly needle placed through the left side of the glans and directly into the corpus cavernosum. After an adequate period of time, saline is infused to create a full erection. This man has a ventral curvature of 65°.

The patient reports the first onset of vibration in the index fingers (positive control), shaft bilaterally, glans and anterior thighs (negative control). Although there are no large-scale studies that have demonstrated its usefulness it can be a useful tool for the patient who presents with erectile dysfunction and Peyronie's disease. It is useful to have a baseline recording for those with complaints of lower sensation after surgery, to ensure that there was no pre-existing abnormality with penile sensation.

Surgical management

Several surgical algorithms have been published as a guide to surgical correction of Peyronie's disease [4,5]. In those patients with mild to moderate curvature (<60–70°) without significant shortening or indentation, a tunica plication type procedure should be performed. This is the preferred method so as to correct the deformity and also reduce the potential risk of erectile dysfunction which appears to be greater in those undergoing grafting procedures. In addition, studies have shown that if the curvature is less than 60°, the amount of penile shortening tends to be tolerable versus those with more severe penile curvature [6].

For those patients with a more severe deformity (>60°) and/or hourglass deformity causing a hinge effect, partial plaque excision or plaque incision with grafting is recommended. The key to a successful outcome is selecting patients who have good to excellent preoperative erectile function. A useful screening tool is to ask the patient as to whether he believes that if the penis was straight, the preoperative rigidity he currently obtains with sexual stimulation would be adequate for penetrative sexual activity. Some men with suboptimal erections will still prefer to undergo the grafting procedure, but should understand that their risk of postoperative erectile dysfunction is higher. Postoperative traction therapy has also been recommended after all grafting and plication procedures to act as a splint to encourage optimum straight healing as well as potential recovery of lost length [7,8]. Further details are discussed in the surgical techniques section.

Risks

The risks of surgery for correction of the curved penis include incomplete straightening, recurrent curvature, penile shortening, alteration in the glans sensation and erectile dysfunction. These should be discussed in detail preoperatively so that the patient has a full understanding of the potential postoperative complications and has appropriate expectations for their outcome. Historically, patients with Peyronie's disease experience a good deal of emotional distress. Therefore it is not uncommon to find patients who have a "successful outcome" from the surgeon's point of view, but are still unhappy with their result.

Outcomes

Surgical outcomes have demonstrated a reasonably high degree of successful straightening with either plication or grafting procedures. The primary concern has been the risks noted above, in particular erectile dysfunction with grafting procedures, and the change in glans sensation and shortening with both plication and grafting procedures [9–11]. Patients should therefore be carefully counseled before surgery as to the risks, as this can clearly have a bearing on the patient outcome.

Patient preparation

The procedure for correction of the penile deformity is usually performed under general or regional anesthesia. Perioperative antibiotics, a proper scrub and shaving of the phallus is advised. Procedures are performed in the supine position and blood loss is minimal. It is advisable to use loupe magnification to enhance visibility, as well as bipolar cautery to reduce the risk of injury to the neurovascular bundle. In addition it is reasonable to use a vasoactive drug such as papaverine, trimix, or prostaglandin to induce an erection. These agents may be injected using a 21-gauge butterfly needle placed through the glans and directly into the corpus cavernosum. Saline infusion can be used with a 60-mL syringe or automatic pump device to create an artificial erection to monitor deformity correction during the operation. A Foley catheter is optional although it can aid urethral mobilization when necessary.

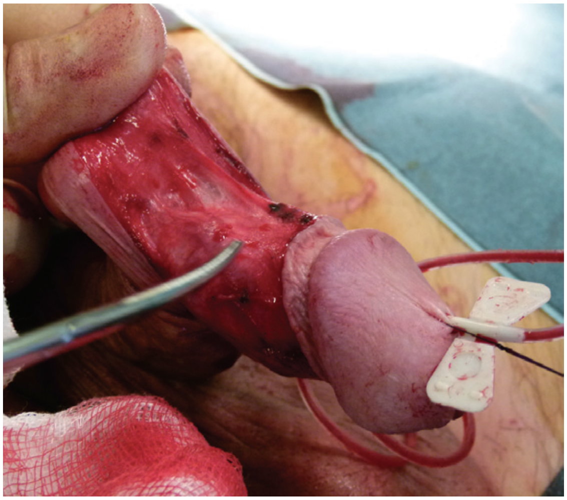

Figure 6.3 A circumcising incision is made and the penis is degloved. The plane between the dartos and Buck's fascia is developed sharply initially. Towards the base of the penis the dartos layer can be bluntly dissected off Buck's fascia.

Surgical techniques

Tunica albuginea plication

The aim of this procedure is to correct a curvature deformity caused by Peyronie's disease. By and large, tunica plication is indicated for curvatures <60° and when some penile shortening is tolerable to the patient. This approach is also preferred for curvatures up to 70° when there is mild erectile dysfunction as the risk of more severe erectile dysfunction is reported with grafting procedures in these men (Figures 6.3, 6.4, 6.5, 6.6. 6.7 and 6.8).

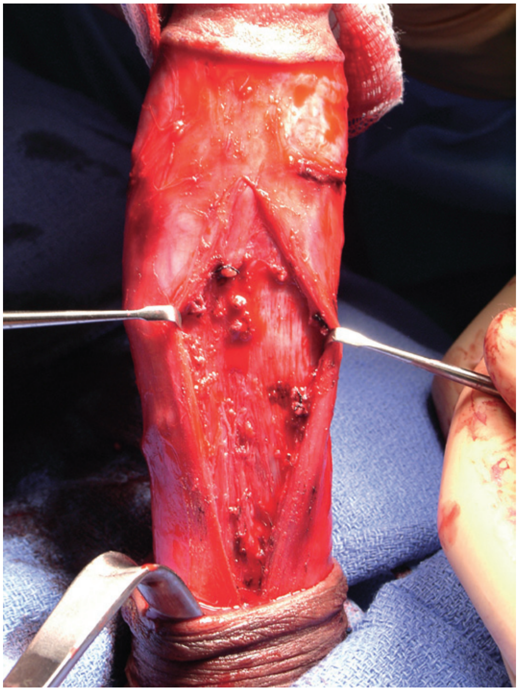

Figure 6.4 Buck's fascia is elevated off the convex side of the penis. The circumflex veins are divided between silk ties. In this case a midline approach is used by elevating and removing a segment of the deep dorsal vein providing access to the underlying tunica. Careful dissection is required to avoid injury to the adjacent neurovascular bundle.

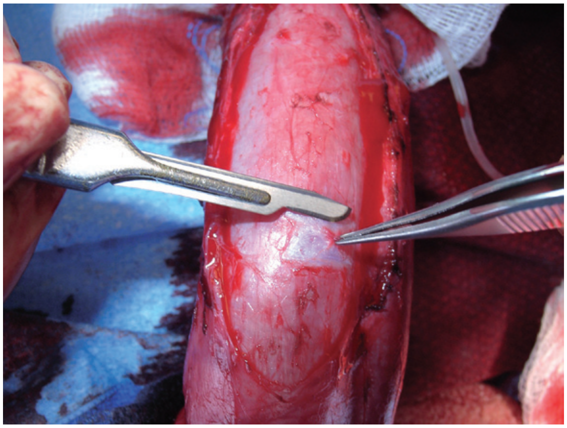

Figure 6.5 A full erection is established using injections of normal saline with either a tourniquet at the base of the penis or compression of the corpora against the pubic bones. The plications are then performed. Two transverse incisions are made approximately 1.0–1.5 cm in length, separated by 0.4–1 cm (depending on the degree of curve to correct), through the longitudinal but not through the circular fibers of the tunica. The intervening tissue is thinned (shaved) to reduce the bulk of the plicated tunica. It is advisable not to exceed a 1.0-cm separation between the plication incision to avoid dog-ears or creating indentations along the shaft.

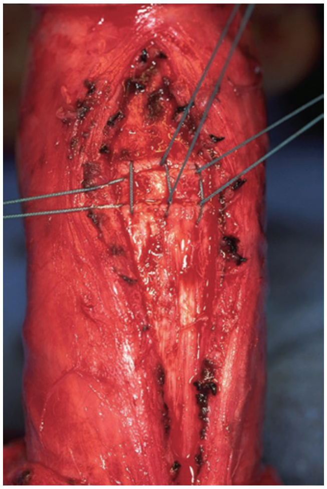

Figure 6.6 The first plication suture (2-0 Tevdek®) is placed in the midpoint of the transverse incision in an inverting vertical mattress fashion. This is reinforced with two to three separate 3-0 polydiaxanone sutures placed in a Lembert fashion. When small plications are made on the distal shaft to correct tunical bulges or minor residual curve one may use one or two 3-0 polydiaxanone only and avoid the permanent suture as the tunica here is thinner.

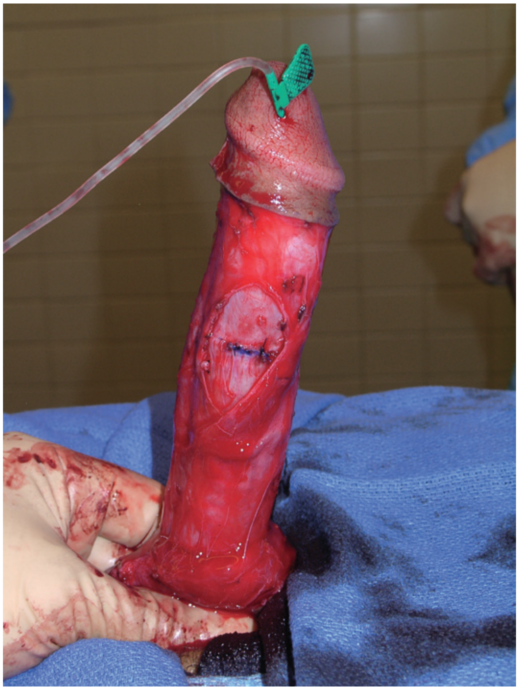

Figure 6.7 The plication process is repeated until the penis is straight.

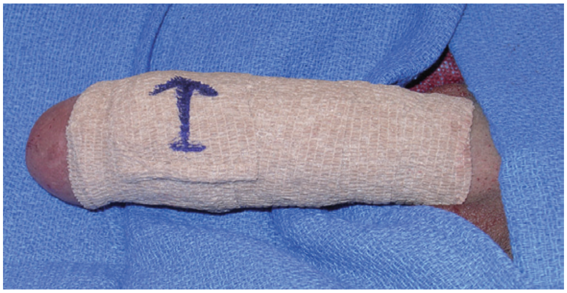

Figure 6.8 Buck's fascia is closed with a running 4-0 chromic suture keeping the penis on stretch. Closure of the subcoronal skin is performed with horizontal mattress 4-0 chromic suture in an interrupted fashion. A ring block with 20 mL 0.25% bupivacaine around the base of the penis is performed. Alternatively, a smaller volume of local anesthetic can be injected directly under Buck's fascia in the region of the neurovascular bundle. A dressing is applied with Xeroform™ Petrolatum Gauze (Covidien AG, Mansfield, MA, USA) around the subcoronal wound and 3M™ Coban™ Self-Adherent Wrap (3M, St. Paul, MN, USA) is applied in a distal to proximal fashion so as to create light compression. Postoperatively the dressing is removed in 3–4 days at which point the patient may shower. Massage and stretch rehabilitation begins 2 weeks postoperatively and sexual activity is not allowed for 6 weeks.

Nesbit and plication procedures

The aim of this procedure is to correct the penile deformity by shortening the longer convex side. This is achieved by either removing an ellipse of tunica albuginea or by placing a series of plication sutures in the tunica until the penis is straight. The procedures are suitable for both Peyronie's disease and congenital chordee (Figures 6.9, 6.10, 6.11, 6.12, 6.13, 6.14, 6.15, 6.16 and 6.17).

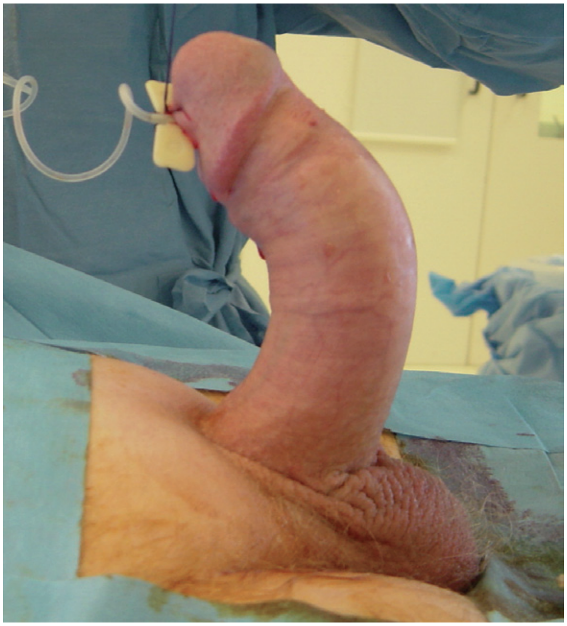

Figure 6.9 Before starting the procedure the penile length and curvature are documented. If there is a significant hourglass deformity then a Nesbit procedure is not suitable as this will cause further narrowing and a hinge effect.

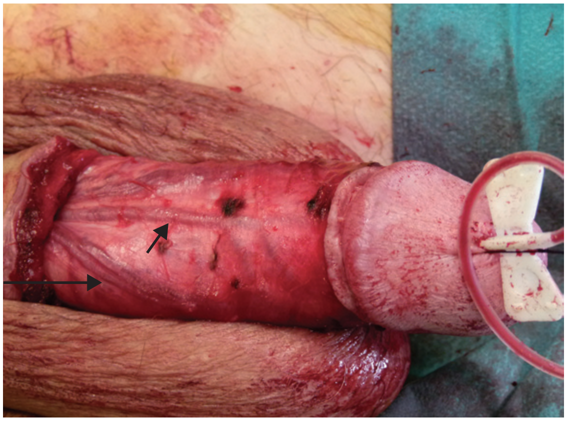

Figure 6.10 A circumcoronal incision is performed and the penis is degloved. The penile skin is sutured to the infrapubic skin and the scrotum in order to keep it away from the operative field. Short arrow pointing to the deep dorsal vein and the long arrow to the dorsal penile artery.

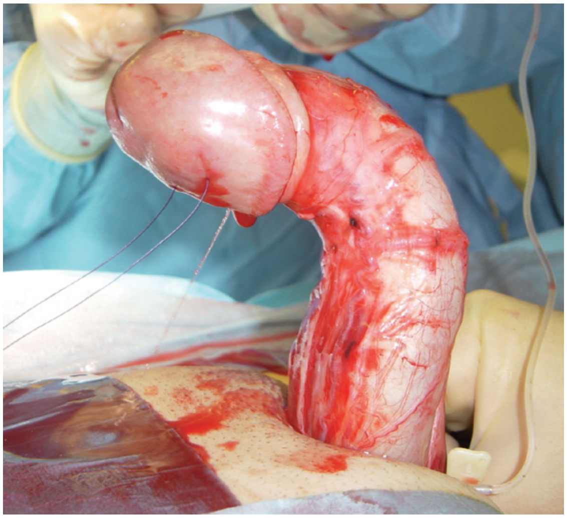

Figure 6.11 A repeat artificial erection is performed. The site of maximum curvature is identified and can be marked using a suture placed on the paraurethral tissues.

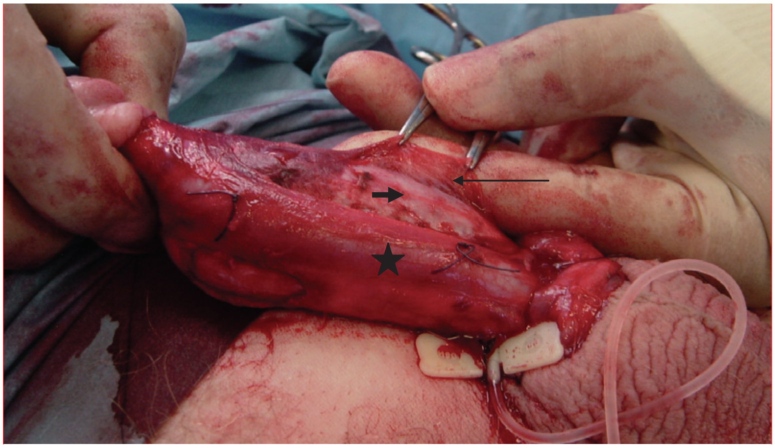

Figure 6.12 For a dorsal curvature, Buck's fascia (long arrow) is incised paraurethrally and mobilized off the underlying tunica albuginea (short arrow). Sharp dissection allows precise mobilization with preservation of the neurovascular bundle. An ellipse can be excised on either side of the urethra (star) or alternatively the urethra can be completely mobilized and a single ellipse excised.

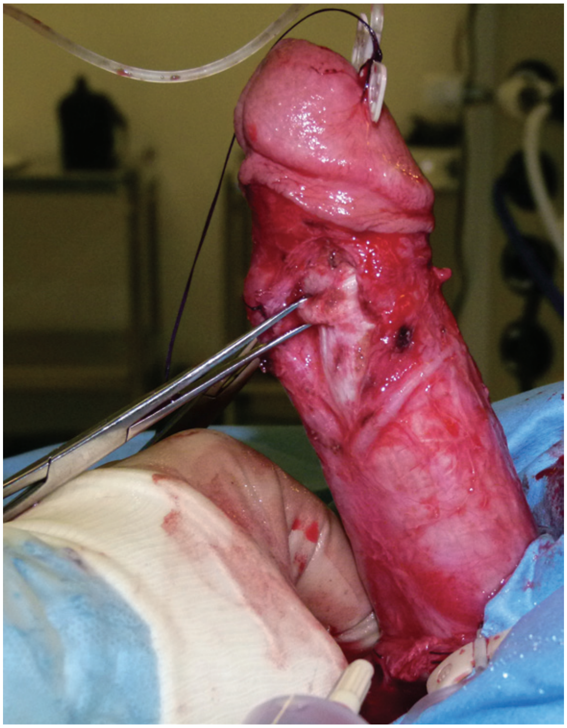

Figure 6.13 An Allis forcep is applied to the tunica while the penis is flaccid in order to estimate the amount of tunica that requires excision. As a general rule 1 mm of tunica is excised for every 10° of curvature. The artificial erection is repeated with the Allis forceps *in situ*. If the residual deformity is acceptable then the marks left by the Allis forceps are used to mark out the tunica that requires excising.

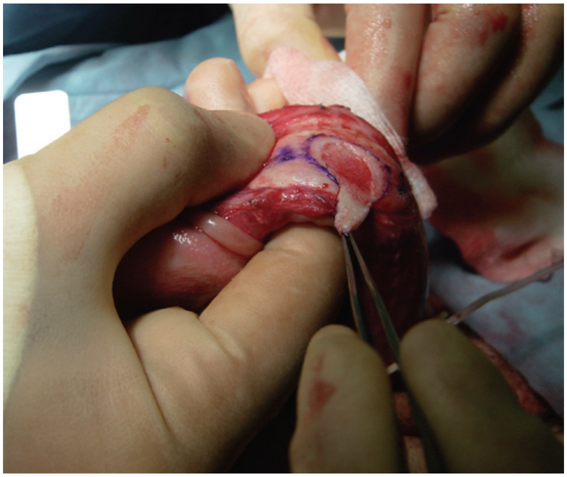

Figure 6.14 The tunical ellipse is marked. The ellipse of tunica is excised ensuring that the underlying cavernosal muscle is not excised. This is repeated on the opposite side if the surgery is for a dorsal curvature.

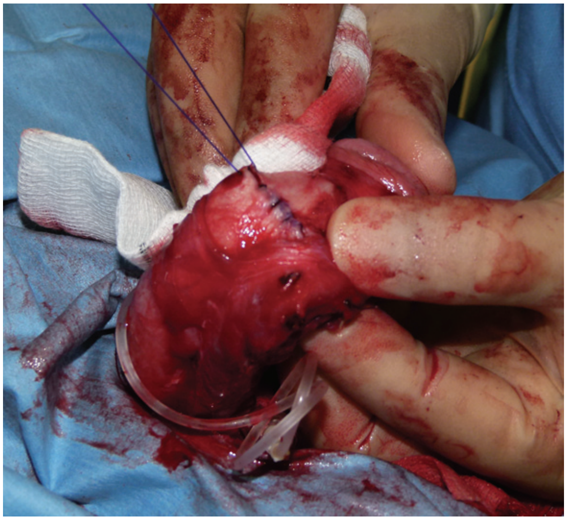

Figure 6.15 The tunical defects are sutured using 0 polydiaxanone sutures. It is important to ensure that the knots are buried. Sutures should be of high tensile strength and patients should be warned that the sutures are palpable for at least 6 months.

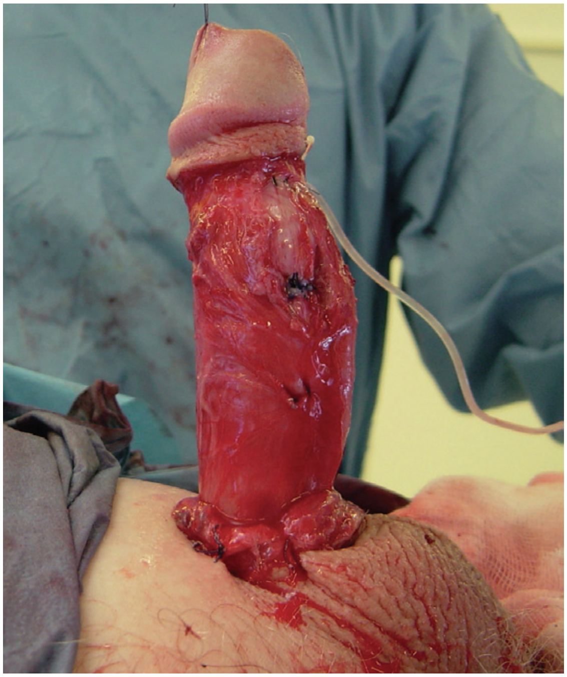

Figure 6.16 A repeat artificial erection is performed. Closure of Buck's fascia with 4-0 polyglactin suture is followed by closure of the subcutaneous and dartos layer while the penis is kept on stretch. The skin is sutured with 4-0 or 5-0 absorbable sutures.

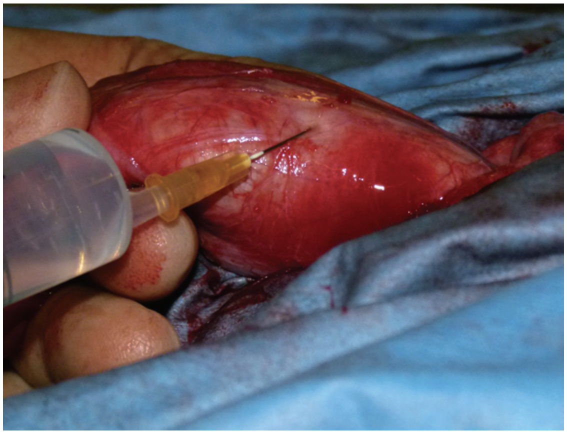

Figure 6.17 Local anesthetic infiltration directly under Buck's fascia is performed.

Modifications of the Nesbit procedure

Yachia procedure

A modification of the Nesbit procedure which avoids excising tunical ellipses has been described by Yachia. In this procedure multiple small longitudinal incisions are made in the tunica albuginea either paraurethrally for dorsal curvatures or in the dorsal midline following mobilization of the neurovascular bundle for ventral curvatures. These are then closed horizontally in a Heineke–Mikulicz fashion using 2-0 or 0 polydiaxanone sutures. Incisions and plications are performed until the penis is straight (Figure 6.18).

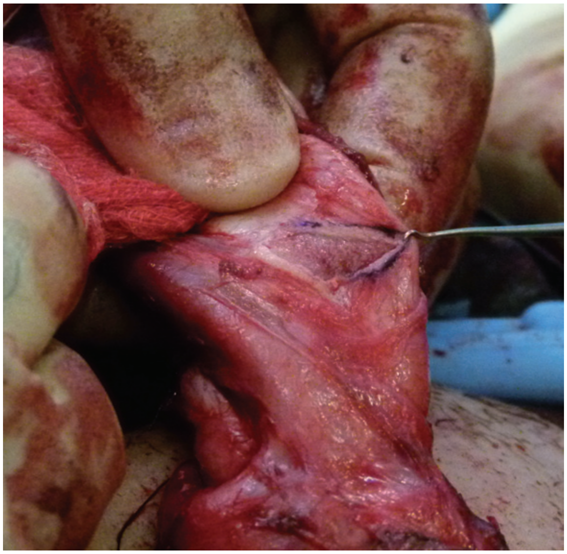

Figure 6.18 A longitudinal incision paraurethrally is sutured horizontally with the aid of skin hooks using 0 polydiaxanone.

16-Dot penile plication

This technique can be performed under local anesthesia with sedation or a general anesthetic. For dorsal curvatures, intracavernosal papaverine or prostaglandin is injected. Once a penile erection has been attained and the center of the curvature identified, either a circumcoronal degloving incision or a longitudinal midline raphe incision is performed. Buck's fascia is mobilized as previously described. Braided 2-0 polyester sutures are used. The entry and exit points of the suture are marked and measured 0.5 cm apart (Figure 6.19). Every four dots correspond to one suture and at least two pairs are required to ensure minimal tension (16 dots). Occasionally three pairs of sutures are required (24 dots). The sutures are tied until the penis is straight.

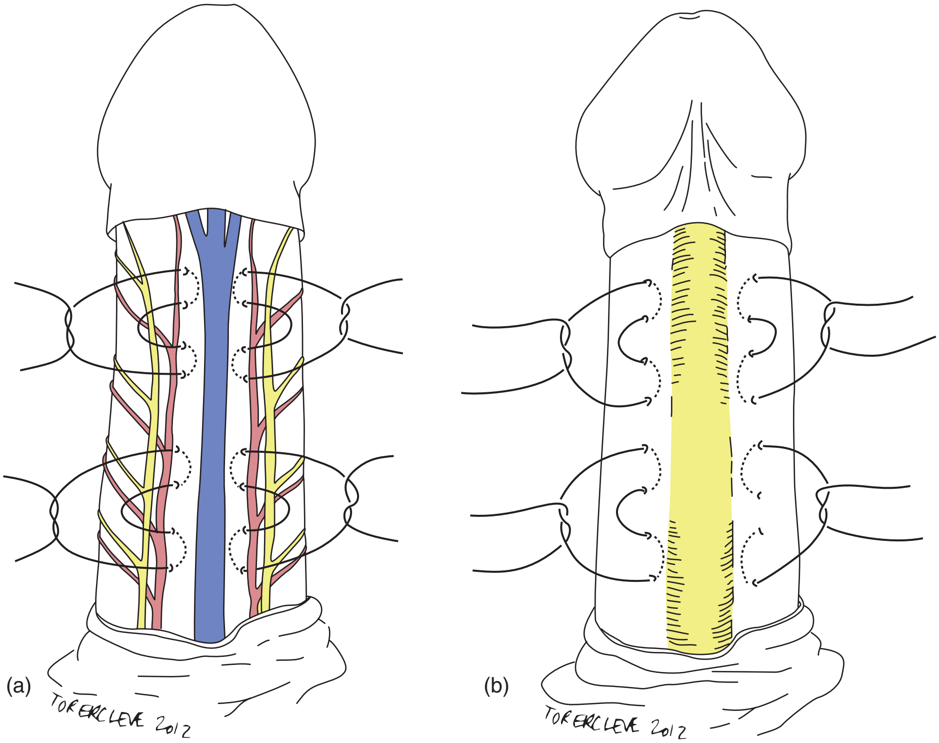

Figure 6.19 The entry and exit points of the 2-0 sutures are marked either on the dorsal or ventral aspect of the penis. (Source: Tor Ercleve. Reproduced with permission of Tor Ercleve.)

Similarly as for ventral curvatures the penile skin can either be degloved using a circumcoronal degloving incision or dorsal longitudinal incision if this is acceptable to the patient (Figures 6.20, 6.21, 6.22 and 6.23). A space between the deep dorsal vein and the dorsal arteries is created and the plication sutures are inserted.

At the end of the procedure the penis is aspirated and injected with an α adrenergic agonist to promote complete detumescence.

Plaque incision with grafting

In cases where the penile curvature is >60° with good erectile function plaque incision and grafting is the procedure of choice. The graft material can range from autologous grafts such as saphenous vein, temporalis fascia, rectus fascia and buccal mucosa. Alternative allografts have been used including small intestine submucosa, bovine and human cadaveric pericardium and Pelvicol™. Synthetic grafts such as Dacron® are avoided because of the associated inflammatory response.

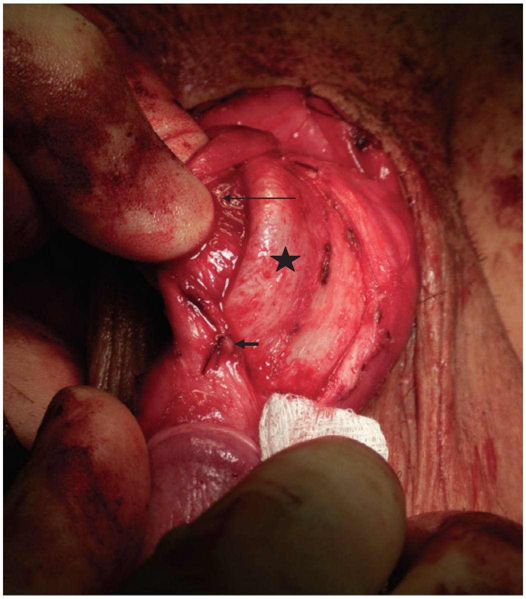

Figure 6.20 The initial steps involve an artificial erection and penile degloving as described previously. For dorsal curvatures the deep dorsal vein is identified and divided shown by the small arrow. Buck's fascia (long arrow) with the dorsal neurovascular bundle is mobilized off the tunica albuginea (starred). In this case Buck's fascia is mobilized from medial to lateral. Alternatively, a paraurethral incision is made and mobilization from lateral to medial can be performed.

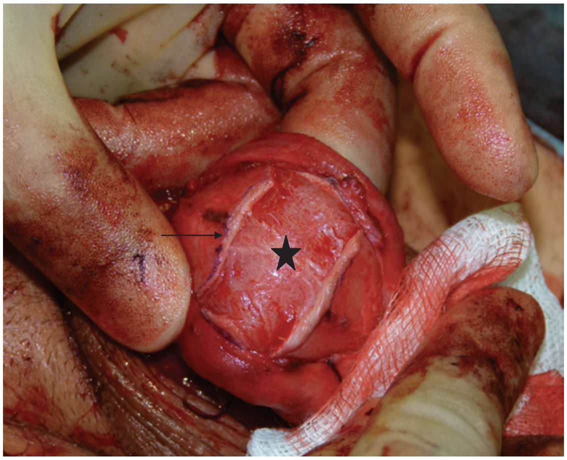

Figure 6.21 Either an "H" incision is made such that the bar of the H is made through the middle of the plaque or a double "Y" incision through the plaque is performed. The limbs of the "Y" can be extended laterally in cases of hourglass deformities and indentations. The edge of the tunica is undermined (long arrow). The underlying corpus cavernosum is shown (star).

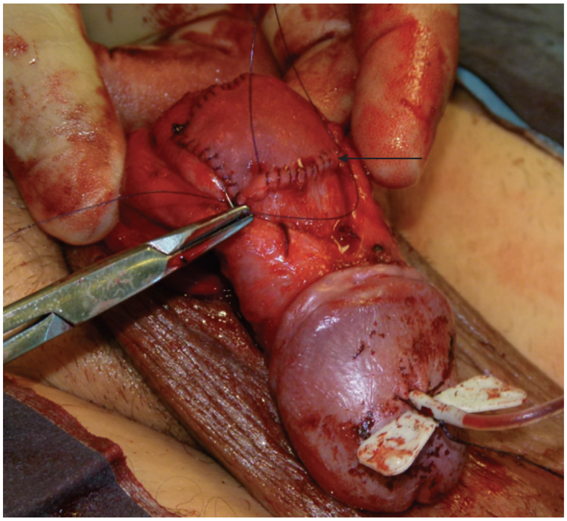

Figure 6.22 The defect is measured and in this case a Pelvicol™ graft (long arrow) is sutured to the edges of the tunica to cover the defect using 4-0 polydiaxanone sutures. A repeat artificial erection is performed to ensure that the penis is straight. Any small residual deformity can be corrected using plication sutures on the contralateral side. Buck's fascia is closed using a running 4-0 polyglactin suture followed by a layered closure as described earlier.

Penile prosthesis for penile curvature associated with erectile dysfunction

A significant curvature or an "hourglass" deformity associated with erectile dysfunction is best managed using a penile prosthesis. This procedure is described in Chapter 7. However, modifications include the use of molding techniques for severe dorsal curvatures. This involves manual molding of the penis with the implant inflated and a rubber shod applied to the tubing to ensure that the lock out valve is not disrupted. Molding is performed for 90 seconds. Additional plication sutures are used for residual curvatures.

Dressings

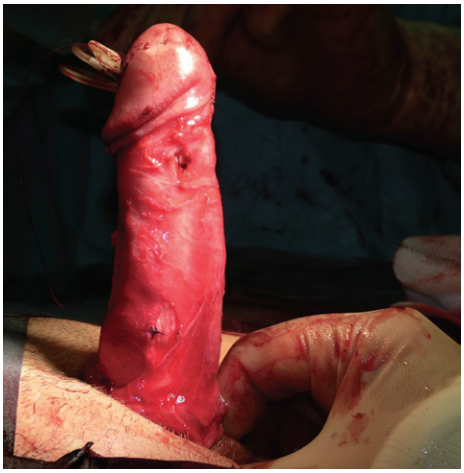

Figure 6.23 A repeat artificial erection shows that the penis is straight.

Postoperative hematomas and swelling to some degree will occur. A gauze dressing followed by a light crepe bandage is recommended. The glans penis should always be visible and checked regularly postoperatively. The penis is kept elevated.

Postoperative care

Patients are advised to refrain from sexual intercourse for 6 weeks. A phosphodiesterase type 5 (PDE-5) inhibitor promotes cavernosal smooth muscle recovery and can be started 1 week following discharge.

Partial plaque excision with pericardial grafting

The aim of this procedure is to correct the curvature as a result of Peyronie's disease. This procedure should only be offered to men with severe curvature (>60°) and/or indentation causing a hinge effect and most importantly when the patient has good to excellent preoperative erectile function with or without PDE-5 inhibitor therapy (Figures 6.24, 6.25, 6.26, 6.27, 6.28, 6.29, 6.30, 6.31 and 6.32).

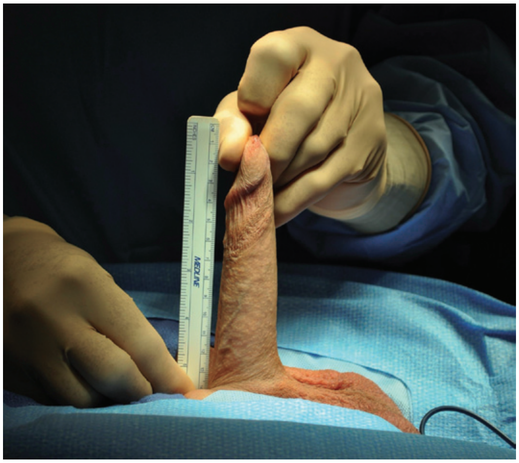

Figure 6.24 The length of the penis is measured on stretch from the base to the corona dorsally.

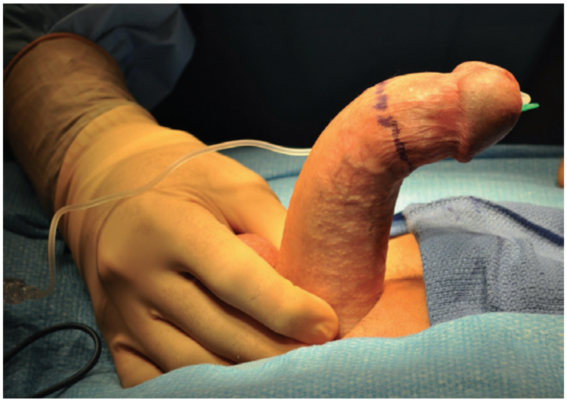

Figure 6.25 The curve of the penis is shown after an erection is created by injecting 60 mg papaverine through a 21-gauge butterfly needle placed through the glans into the corpus cavernosum. After an adequate period of time, saline is infused to create a full erection.

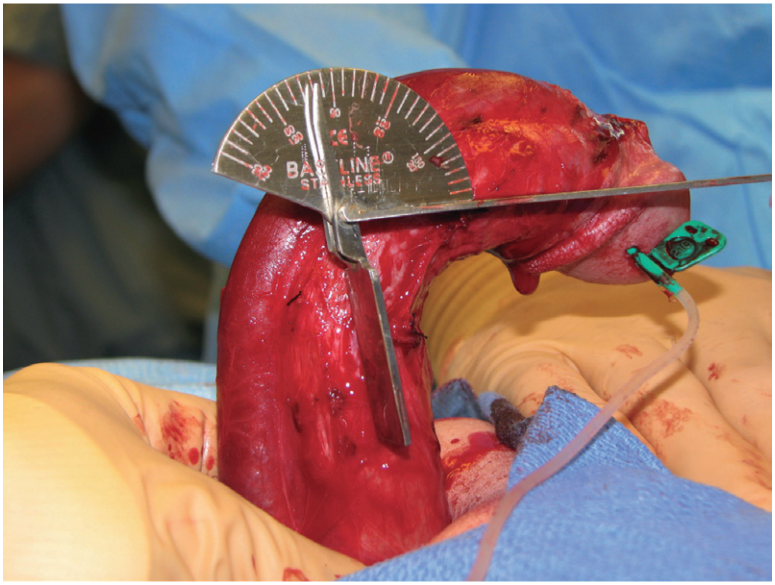

Figure 6.26 A circumcising incision is made and the penis is degloved. The curvature of the penis is measured using a goniometer.

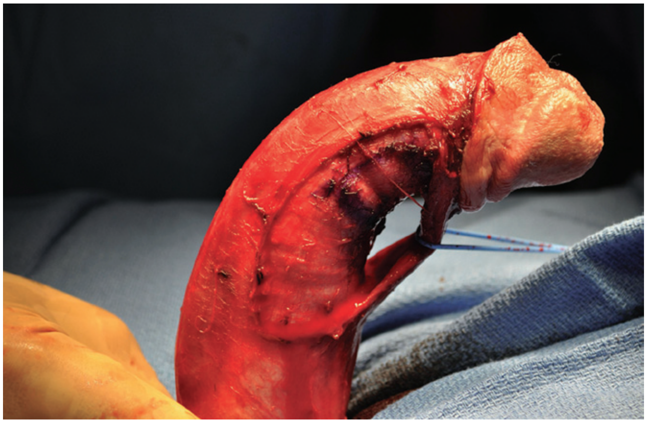

Figure 6.27 Buck's fascia is elevated off the area of maximum deformity by making a pair of parallel incisions just lateral to the urethra. The circumflex veins are divided between silk ties. Loupe magnification and bipolar electrocautery is used throughout the procedure so as to reduce the likelihood of injury to the dorsal neurovascular structures. A dorsal approach (through the deep dorsal vein bed) to elevate the neurovascular bundle is an option but may not provide adequate ventrolateral exposure particularly when there is significant lateral or ventrolateral indentation or hourglass deformity. Therefore we prefer to use bilateral ventral urethral ridge incisions. A marking pen is used to delineate the area that is most severely involved, which is subsequently excised with careful attention to minimize injury to the underlying cavernosal tissue. The corners are darted in a radial fashion so as to prevent cicatrix contracture and to help correct indentation deformities.

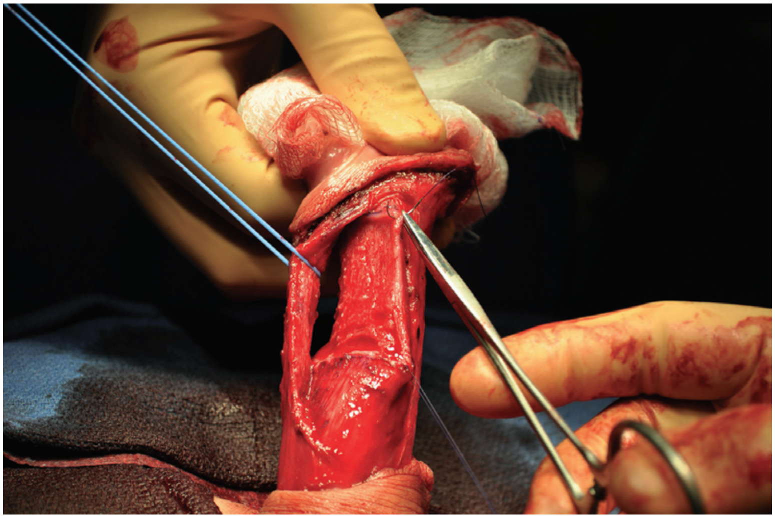

Figure 6.28 4-0 Polydiaxanone is placed in the four corners of the tunica defect, as well as at the midpoint on both transverse aspects.

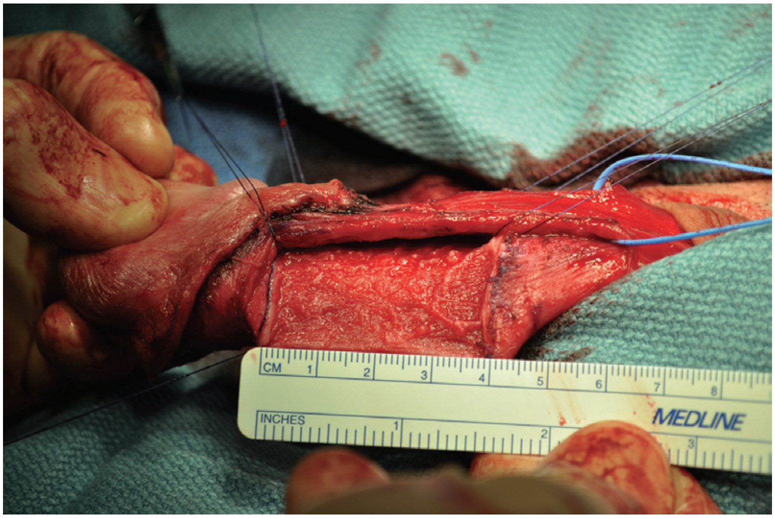

Figure 6.29 The distances between the corners of the tunical defect are measured under full stretch. When measuring transversely, measure from corner to center stay suture and then stay suture to the opposite corner. Do not be surprised at the size of the defect, as we routinely place 4–6 cm × 5–7 cm grafts. A Tutoplast™ (Coloplast Corporation, Minneapolis, MN, USA) processed human pericardial graft is allowed to soak for 20 minutes in an antibiotic solution or saline. The graft is cut to fit the measured dimensions of the defect, as this graft does not tend to contract.

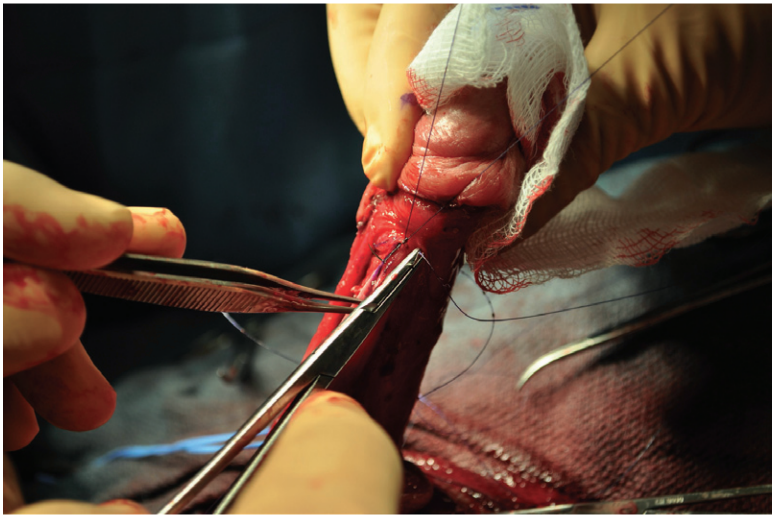

Figure 6.30 4-0 Polydiaxanone is used in a running fashion to secure the graft to the native tunica albuginea along each of the four borders. Two to three 4-0 polydiaxanone interrupted stitches are used to tack the midline of the graft to recreate the septum.

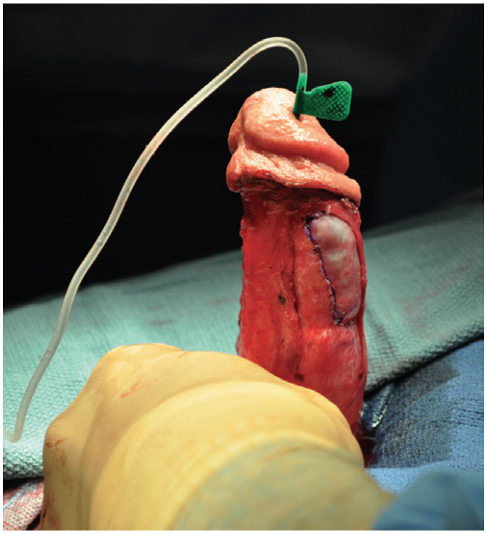

Figure 6.31 An artificial erection is created with injection of normal saline through the butterfly needle.

Key tips

It is important to accurately assess the degree of curvature and erectile function preoperatively. It is also important to ensure that the patient's expectations are realistic.

As a general rule curvatures <60° can be corrected using a Nesbit procedure. Those >60° with good erectile function require some form of grafting. In patients with erectile dysfunction or significant waist deformities a penile prosthesis is the best option.

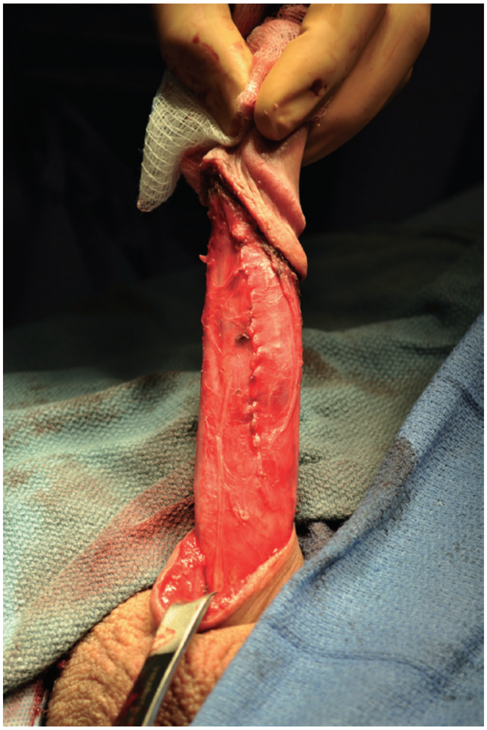

Figure 6.32 Buck's fascia is closed with running 4-0 chromic bilaterally followed by closure of the subcoronal skin with horizontal mattress 4-0 chromic in an interrupted fashion. A ring block with 20 mL 0.25% bupivacaine around the base of the penis is performed. In uncircumcised men a circumcision is recommended if there is any preoperative phimosis. A dressing is applied with Xeroform™ Petrolatum Gauze (Covidien AG, Mansfield, MA, USA) around the subcoronal wound and a 3M™ Coban™ Self-Adherent Wrap (3M, St. Paul, MN, USA) was applied from distal to proximal in a fashion so as to create light compression.

References

1 Del Carlo M, Cole AA, Levine LA. Differential calcium-independent regulation of matrix metalloproteinases and tissue inhibitors of matrix metalloproteinases by interleukin-1beta and transforming growth factor-beta in Peyronie's plaque fibroblasts. J Urol 2008;179:2447–55.

2 Taylor FL, Levine LA. Non-surgical therapy of Peyronie's disease. Asian J Androl 2008;10:79–87.

3 Ohebshalom M, Mulhall J, Guhring P, Parker M. Measurement of penile curvature in Peyronie's disease patients: comparison of three methods. J Sex Med 2007;4:199–203.

4 Levine LA, Lenting EL. Experience with a surgical algorithm for Peyronie's disease. J Urol 1997;158:2149–52.

5 Ralph DJ. The surgical treatment of Peyronie's disease. European Urology 2006;50:196–8.

6 Greenfield JM, Lucas S, Levine LA. Factors affecting the loss of length associated with tunical albuginea plication for correction of penile curvature. J Urol 2006;175:238–41.

7 Levine LA, Newell MM, Taylor FL. Penile traction therapy for the treatment of Peyronie's disease: A single-center pilot study. J Sex Med 2008;5:1468–73.

8 Moncada-Iribarren I, Jara J, Martinez-Salamanca JI, et al. Managing penile shortening after disease surgery. J Urol 2007;177(Suppl 4):253,750A.

9 Knoll LD. Use of small intestinal submucosa graft for the surgical management of Peyronie's disease. J Urol 2007;178: 2474–8.

10 Lue TF, El-Sakka AI. Venous patch graft for Peyronie's disease. Part I: Technique. J Urol 1998;160:2047–9.

11 Taylor FL, Levine LA. Surgical correction of Peyronie's disease via tunica albuginea plication or partial plaque excision with pericardial graft: Long-term follow up. J Sex Med 2008;5:2221–8.

7

Surgery for Erectile Dysfunction

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Introduction

Erectile dysfunction (ED) has a significant effect on a man's quality of life. However, phosphodiesterase (PDE-5) inhibitors such as sildenafil, tadalafil and vardenafil have provided effective treatment and changed the public perception of ED. While PDE-5 inhibitors allow a successful first line approach, the treatment of ED refractory to oral pharmacotherapy has remained largely unchanged. Second line treatment using intraurethral or intracavernosal prostaglandins will be effective in a proportion of patients failing PDE-5 inhibitor treatment or those where PDE-5 inhibitors are contraindicated. Finally, a vacuum device can be offered as an alternative for those wanting a minimally invasive option. Failing all of these options, surgical implantation of a penile prosthesis provides a reliable and effective way to restore sexual function. Successful outcomes with penile prostheses are dependent on surgical expertise and careful management of patient's expectations.

Clinical features

Implantation of a penile prosthesis is a surgical solution for endstage ED and requires preoperative counseling to address the patient's expectations. The most common conditions resulting in endstage ED include diabetes, Peyronie's disease, as a result of prolonged priapism and following major pelvic surgery (e.g. radical prostatectomy). *De novo* erectile dysfunction can also develop following surgery to correct Peyronie's disease (Table 7.1). Erectile dysfunction occurs in approximately 10% of patients following plication procedures and 20–50% following grafting procedures.

Therefore, in patients with both Peyronie's disease and erectile dysfunction, it is important to assess the preoperative response to PDE-5 inhibitors or intracavernosal prostaglandin. Patients demonstrating a poor response to pharmacologic therapy should be offered a penile prosthesis which will address both issues of penile curvature and ED.

Surgical management

There are three categories of penile prosthesis: semi-rigid malleable rods, two-piece hydraulic penile prostheses and three-piece hydraulic penile prostheses (Table 7.2). The most commonly used implants are manufactured by American Medical Systems (AMS; Minnetonka, MN, USA) and Coloplast (Minneapolis, MN, USA).

Semi-rigid malleable rods

These are the easiest implants for both the patient to use and the surgeon to insert, being associated with the lowest risk of mechanical failure (0.5%). As the device maintains the same rigidity all the time, the patient is simply taught to bend the penis upright for intercourse and to point it downwards to pass urine.

The two main types of malleable prosthesis currently used are the AMS Spectra™ and the Coloplast Genesis™ device. The Spectra prosthesis consists of a central malleable section made of articulating polymer and metal segments, with a cable running through the center attached to springs at either end. The outer surface is Gore-Tex® covered with a layer of silicone. It is available in diameters of 9.5, 12 and 14 mm, and in lengths of 12, 16 and 20 cm. The implant can be made up to the required length using additional rear tip extenders, allowing an extra 0.5–7.5 cm.

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Table 7.1 Indication for penile prosthesis surgery

Refractory erectile dysfunction
Inability to tolerate and/or dissatisfaction with alternative therapies
Refractory ischemic priapism
Peyronie's disease with concurrent erectile dysfunction

Table 7.2 Types of penile implant

Semi-rigid malleable rods	Coloplast Genesis™ AMS Spectra™
Two-piece hydraulic penile prosthesis	AMS Ambicor®
Three-piece hydraulic penile prosthesis	AMS 700™ MS Series – CX, CXR, LGX Coloplast OTR Series – Titan®, Narrow base (previously known as Mentor Alpha) Coloplast Titan® Zero Degree

The Genesis™ implant is made from silicone with a central metal core and a hydrophilic coating, allowing it to absorb antibiotics by soaking the implant prior to implantation. It is available as a 9.5 mm (diameter) × 23 cm (length), 11 mm × 25 cm or 13 mm × 27 cm sized cylinder. These cylinders are then cut to size, and each comes with a selection of rear tip extenders to allow an addition of up to 2 cm in length. The devices are reliable, easy to insert and provide good rigidity.

Two-piece hydraulic penile prosthesis

The AMS Ambicor® consists of paired cylinders preconnected to an activation pump, which is placed within the scrotum in a dartos pouch. This device has no separate reservoir, and activation of the pump shifts the prefilled fluid from the reservoir in the proximal end of the device to the distal cylinders in order to provide penile rigidity. The advantage of a lack of an intra-abdominal reservoir may be useful in patients with a history of pelvic trauma, extensive previous lower abdominal surgery or renal transplantation. However, the Ambicor® device is best used in patients who have a good sized penis to begin with, as the diameters are 12.5, 14 and 15.5 mm.

Three-piece hydraulic penile prosthesis

This consists of paired cylinders with an activation–deactivation pump placed in the scrotum and a separate reservoir, which is placed in the retropubic space. Although patients can achieve rigidity and flaccidity by cycling the device using the pump, the three-piece devices are more prone to mechanical failure and infection given their technical complexity and the longer and more intrusive procedure required for insertion.

There are a number of different three-piece inflatable prostheses available. The AMS 700™ is available as a standard CX device, allowing girth expansion, an LGX device, allowing both length and girth expansion, and a CXR device, which allows for girth expansion but is available at narrower diameters (9.5 mm) for difficult cases with extensive corporal fibrosis (e.g. post priapism or following previous implant infection). All devices are available with a "momentary squeeze" (MS) tactile pump, which has a one-touch deflation and lock out valve to prevent autoinflation. AMS implants have a three-layer construction, with a central woven fabric cylinder made of Dacron® and Lycra® sandwiched between two silicone-coated cylinders. In the standard CX and CXR devices, the central cylinder's weave is unidirectional, while in the LGX it is bidirectional allowing both length and girth expansion. All cylinders are micro-coated with Parylene™ to improve durability. Over the last decade since 2000, AMS implants have also been impregnated with Inhibizone, a combination of rifampin and minocycline to reduce the risk of infection. AMS CX and LGX devices are available in 11 mm diameters, with lengths of between 12, 15, 18 and 21 cm. The CXR is available with lengths 12–18 cm. Additional rear tip extenders of between 0.5–7.5 cm can also be added.

The Coloplast Titan® three-piece hydraulic prosthesis is available in standard and narrow base options and the most recent device launched is called the Titan® Zero Degree (Figure 7.1). The standard Titan® cylinders are

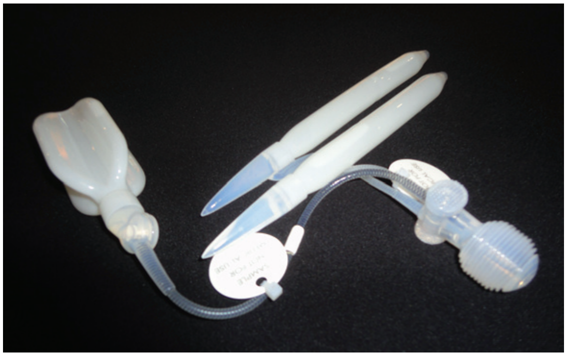

Figure 7.1 The Titan® Zero Degree inflatable implant. The zero degree angle of the proximal tubing allows easier placement than the current Coloplast Titan®.

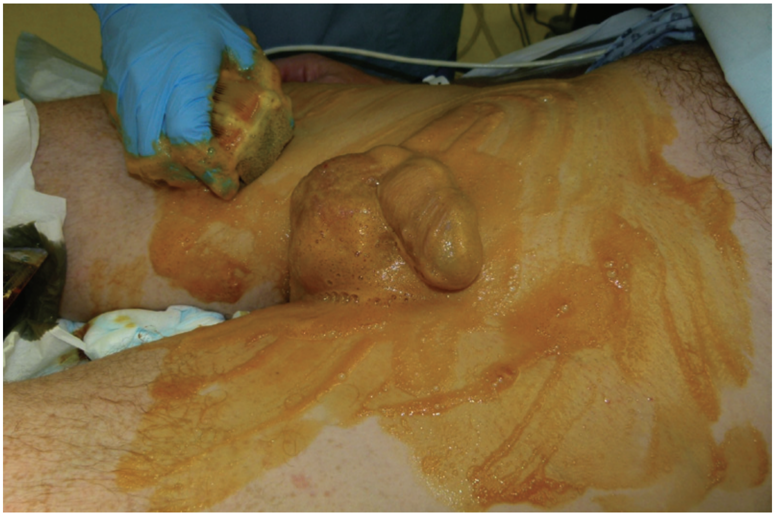

Figure 7.2 The patient undergoes hair removal in theater and the operative area is scrubbed with betadine for 10 minutes.

available in lengths of 14–22 cm in increments of 2 cm. The narrow base cylinders are available in 10–18 cm also in increments of 2 cm. Both are available with a one-touch release (OTR) tactile pump for faster and easier deflation. The lockout valve on the Coloplast device is attached to the reservoir, and effectively prevents autoinflation secondary to increases in intra-abdominal pressure. Devices are made of a tough Bioflex$^{\text{TM}}$ material, and expand in girth only. For the last 10 years they have been made with a hydrophilic coating, which allows the device to absorb any antibiotic it is soaked in. A lot of work has recently been published on the relative benefits of different antibiotic soak solutions, but the combination of rifampin and gentamicin, and the more cost effective combination of trimethoprim and sulfamethoxazole, have both shown an efficacy equal to, if not better than, Inhibizone for the most common organisms found to infect penile implants.

Patient preparation

Patients with ED also have a high prevalence of diabetes, and it is essential to ensure that they are optimized for surgery. Such patients must have good diabetic control in the pre-, peri-, and postoperative periods in order to minimize their increased risk of infection. The current reported rates are 4–10% in the diabetic group. A preoperative glycosylated hemoglobin (HbA1c) level should be performed, and a level of 70–75 mmol/mol (8.5–9%) or greater requires the input of a diabetologist. All patients must have sterile urine, and be free from any local skin infection, or colonization with high risk bacteria such as methicillin-resistant *Staphylococcus aureus* (MRSA) prior to surgery.

Patients should have hair removal at the surgical site while in the operating theater. The area should be scrubbed for 10 minutes with an iodophor such as betadine, which is effective against a broad spectrum of Gram-positive and Gram-negative bacteria found typically in the genital region (Figure 7.2). The surgical field is then prepared, again using betadine, and finally in our practice the area is cleaned with alcoholic chlorhexidine gluconate before draping the patient. It is essential to allow the alcohol to fully air dry before any incision is made. All patients should receive prophylactic intravenous antibiotics on induction of anesthesia to ensure adequate circulating levels of antibiotic prior to performing a surgical incision. A regime which covers Gram-positive and Gram-negative bacteria is essential, typically co-amoxiclav and gentamicin, or clindamycin and gentamicin in penicillin allergic patients. All patients are catheterized on the operating table to allow easy identification of the urethra during the procedure, with the catheter drawn through a betadine-soaked swab after insertion to minimize contamination.

Theater set up

Cases should be performed in theaters with positive pressure ventilation, or laminar flow if available. The traffic in the operating theater should be kept to a minimum during implant cases to limit the microbial levels. Doors should be locked to prevent needless unauthorised entry, and signs displayed to warn passers-by that prosthetic surgery is being performed. All staff in theater should wear surgical masks to cover the nose and mouth. The operating list should be sensibly ordered to ensure that an implant case does not follow an infected case.

Specialist equipment

Metal Scott retractors are excellent in allowing maximal exposure through a relatively small penoscrotal incision. A range of dilators can be used during the procedure, each with its own advantage. Metal Hegar dilators in sizes ranging 8–14 mm are sufficient for most cases (Figure 7.3). In patients with larger abdomens, metal Brooks dilators which have an olive tip are easier to use as their angled handle allows easier distal corporal dilatation in patients with prominent supra-pubic fat pads (Figure 7.4). Rossello dilators are reserved for cases with marked corporal fibrosis, where their back cutting teeth work with a rasping action to grate the scarred tissue. Access to all three types in the operating theater is recommended to cover any eventuality during surgery. A long nasal speculum should also be available if blind reservoir insertion is to be contemplated.

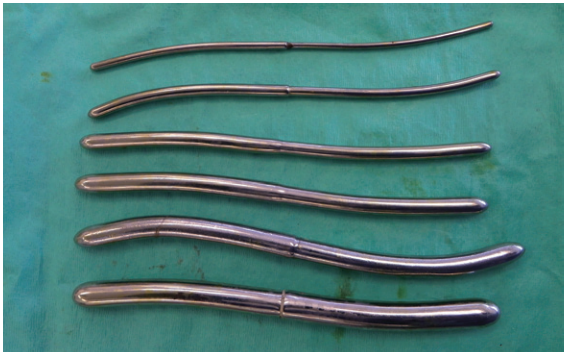

Figure 7.3 Hegar dilators allow sequential dilatation of the corpora.

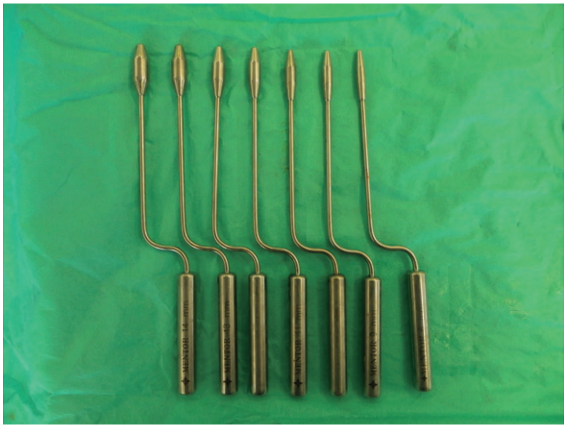

Figure 7.4 Olive tipped Brooks dilators are useful in obese patients.

Surgical risks

Infection

Infection following penile prosthesis insertion is uncommon and seen in approximately 1–2.5% of implants on long-term follow-up. Higher rates of infection are seen in patients with a history of diabetes, spinal cord injury, patients on steroid therapy and in revision implant cases. It usually manifests with localized signs including erythema and a purulent discharge with or without wound dehiscence. Occasionally, the presentation may be more subtle, but infection should always be suspected in cases of penoscrotal pain which is disproportionate to local signs, or in the presence of any systemic symptoms. When one part of the prosthesis is infected, an assumption is made that all of the components are colonized, and plans made for immediate removal.

Mechanical failure and autoinflation

The most common mechanical problem is due to wear and tear of the tubing or junctions, resulting in fluid leaking out from the system. This will manifest as a pump that fails to recoil on squeezing.

Implant erosion

Distal erosion of the cylinders is uncommon and can be due to oversizing of the prosthesis, or excessive distal dilatation with corporal tip perforation. It may also arise as a consequence of circumstances, such as infection or after distal shunt surgery for priapism.

SST deformity

A "floppy" glans or Supersonic tilt (SST) deformity refers to the glans having inadequate support on the corporal tips following prosthesis insertion. This may arise due to a number of factors, and the cause must be elucidated prior to repair. Imaging the inflated implant with ultrasound or magnetic resonance imaging (MRI) is often required to exclude a posterior crural perforation as a potential cause, although typically this will usually produce a one-sided tilt. It will also visualize whether there is inadequate dilatation of the distal corpora.

Surgical outcomes

Penile prosthesis surgery remains an end stage surgical option for erectile dysfunction that is refractory to pharmacotherapies. Both patient and partner satisfaction rates remain high above 85% and infection rates are less than 2% in high volume centers. In patients with extensive Peyronie's disease and erectile dysfunction, inserting a penile prosthesis not only allows correction of the penile deformity, but also ensures that the penis has enough rigidity to allow sexual intercourse.

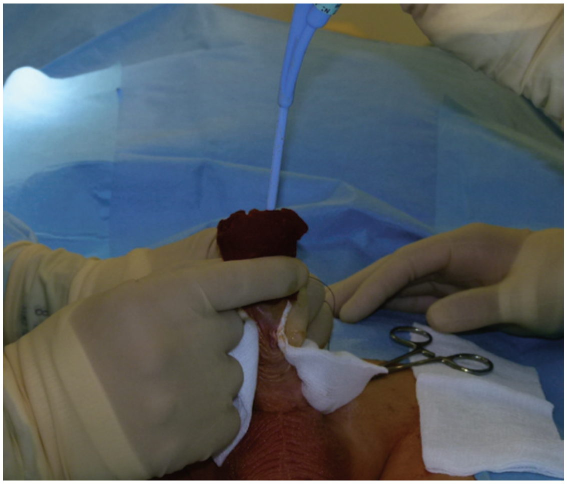

Figure 7.5 A urethral catheter is inserted. Betadine-soaked gauze is used to wipe the catheter.

Surgical technique

Surgical approach

A range of surgical approaches can be used. A penoscrotal incision provides an ideal approach for both malleable and inflatable implants. It can be combined with a circumferential degloving incision if a patient has scarred corpora necessitating multiple corporotomies. An alternative approach for three-piece devices is an infrapubic incision.

For placement of a malleable prosthesis, a subcoronal or ventral penile incision can also be used. The former is better suited to the AMS Spectra™ device, which would otherwise require longer corporotomies if inserted via a penoscrotal or ventral penile approach.

Insertion of a penile prosthesis

See Figures 7.5, 7.6, 7.7, 7.8, 7.9, 7.10, 7.11, 7.12, 7.13, 7.14, 7.15, 7.16, 7.17, 7.18, 7.19, 7.20, 7.21, 7.22, 7.23, 7.24, 7.25, 7.26, 7.27, 7.28 and 7.29.

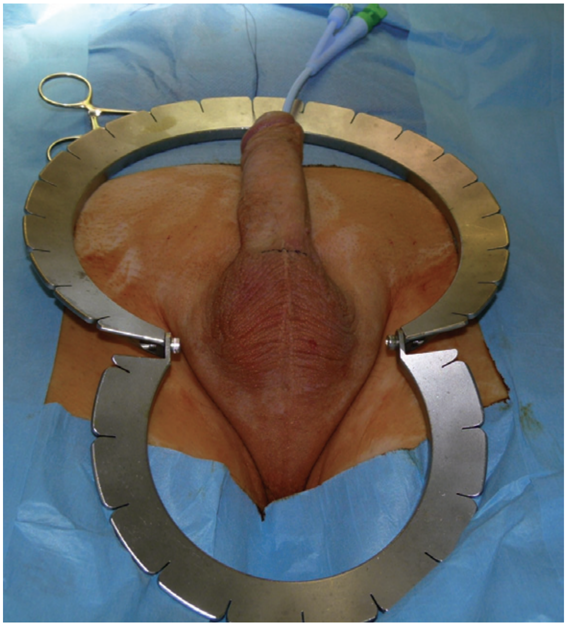

Figure 7.6 The site of the penoscrotal incision is marked 1 cm below the penoscrotal junction. The Scott retractor is positioned.

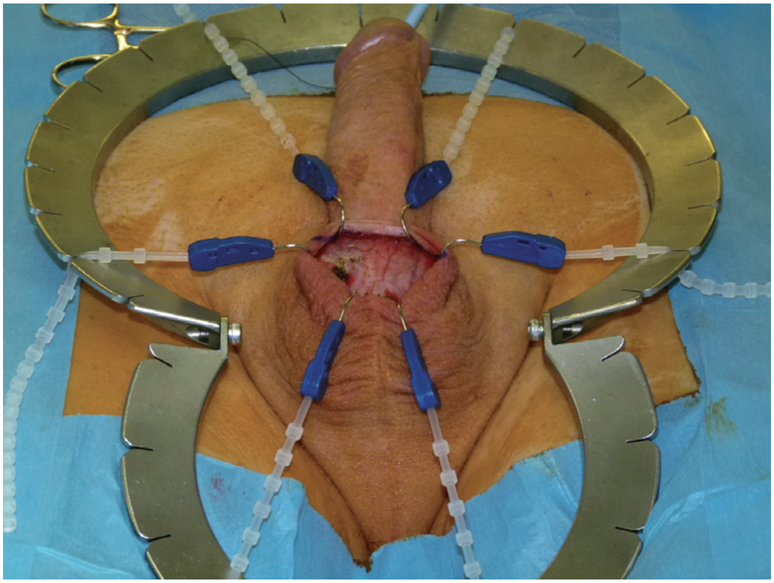

Figure 7.7 The subcutaneous tissue is dissected. The hooks on the Scott retractor aid dissection of the dartos and subcutaneous tissue.

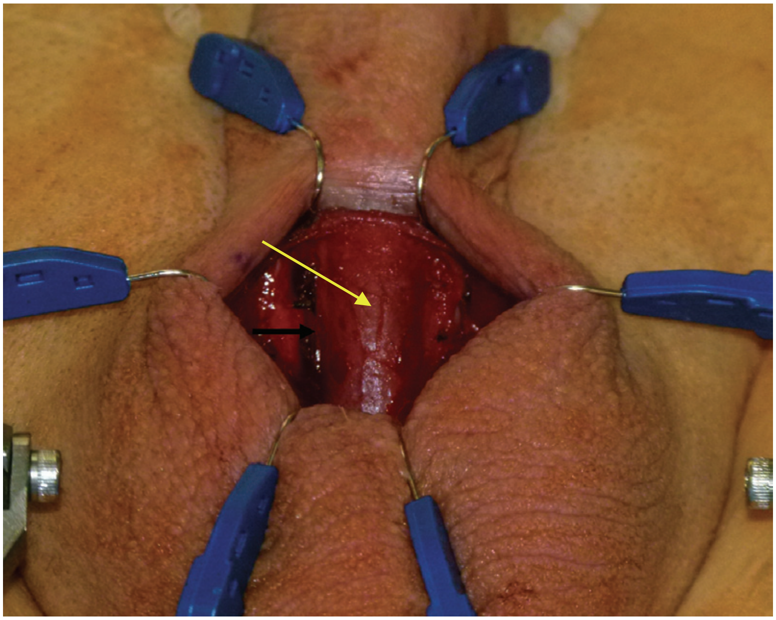

Figure 7.8 The urethra is identified and exposed (yellow arrow). The corpora are exposed bilaterally (black arrow).

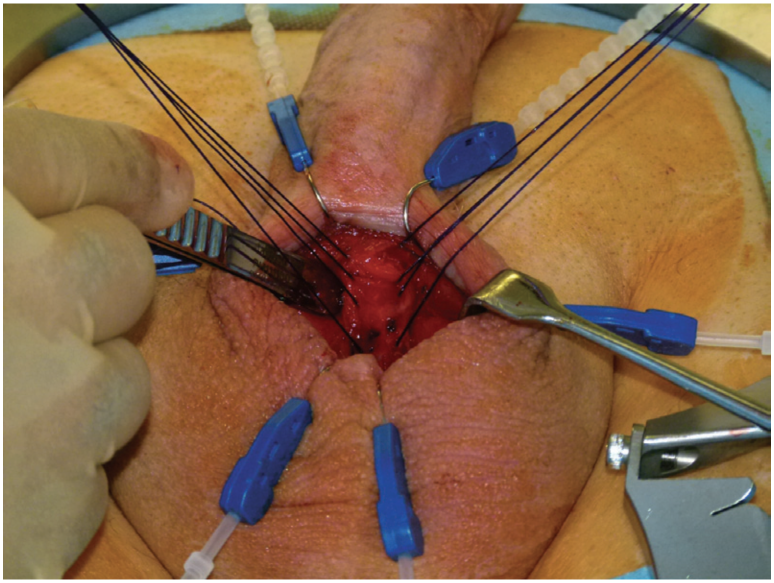

Figure 7.9 A series of 0 polyglactin sutures are placed in the tunica albuginea of the left corpora parallel to the urethra which is drawn medially by the forceps. The sutures can be tied over to close the corporotomy after the cylinders have been inserted.

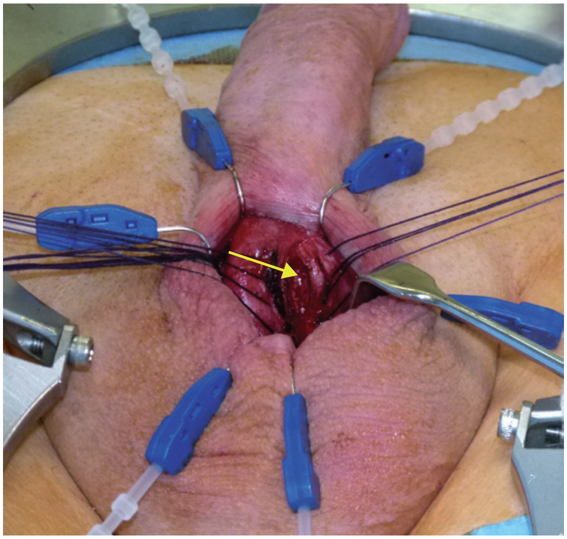

Figure 7.10 A corporotomy (yellow arrow) is performed between the stay sutures using a scalpel or pure cutting diathermy. This is repeated on the right corpora. The position of these corporotomies should be sufficiently low enough on the corpora to allow a low placement of the exit tubing from the cylinders if a three-piece device is inserted.

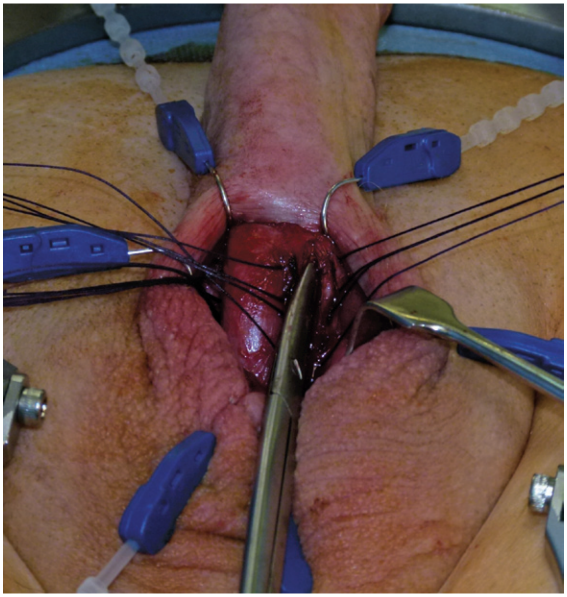

Figure 7.11 The corporal bodies can be dilated first with Metzenbaum scissors. The scissors should be directed laterally to prevent inadvertent injury to the urethra. As they are withdrawn, the scissors can be gently opened and closed to make a channel within the corpora.

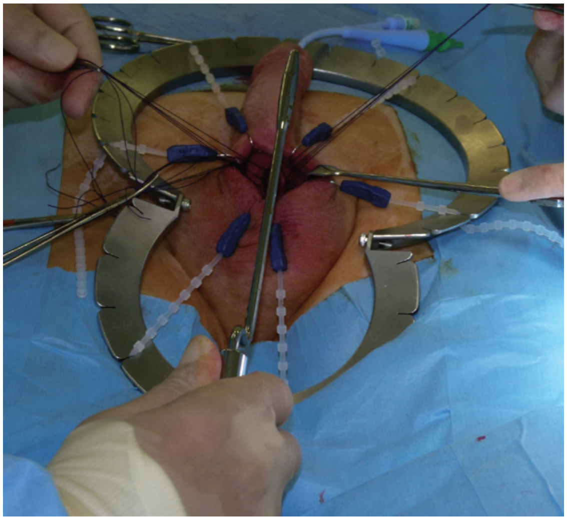

Figure 7.12 Sequential dilatation is performed using Brooks dilators. Alternatively, Hegar dilators can be used. Dilatation continues until one size up from the prosthesis diameter (i.e. up to 12 mm Brooks for 11-mm diameter prosthesis). The dilators are directed laterally during the dilatation.

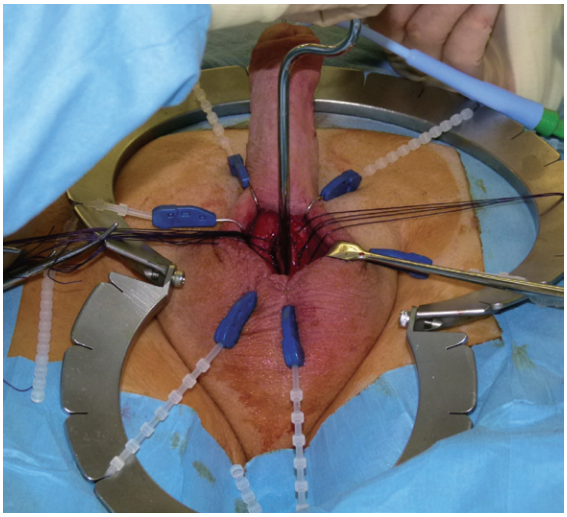

Figure 7.13 Sequential dilatation of the proximal corpora bilaterally is then performed. Gentle dilatation until the tip reaches the pubic bone indicates that the proximal limit has been reached.

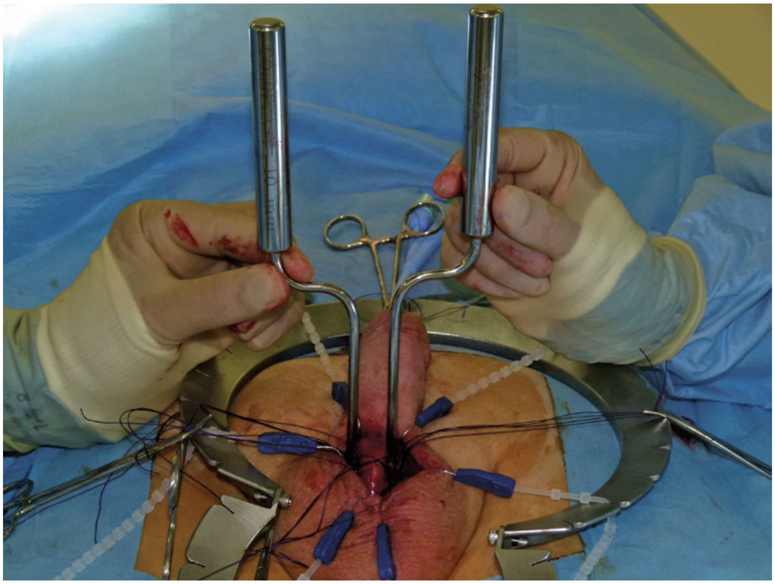

Figure 7.14 Paired dilators can then be inserted in both corpora simultaneously to ensure an equal dilatation with no posterior crural perforation.

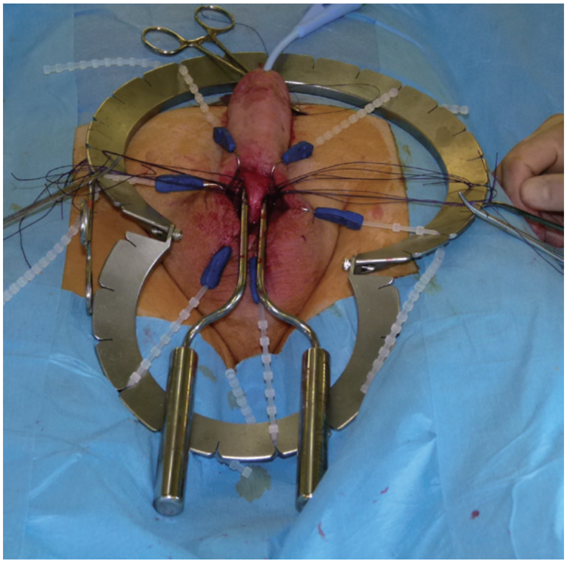

Figure 7.15 The distal dilatation is also checked to ensure that there is no inadvertent crossover and that the dilatation is equal.

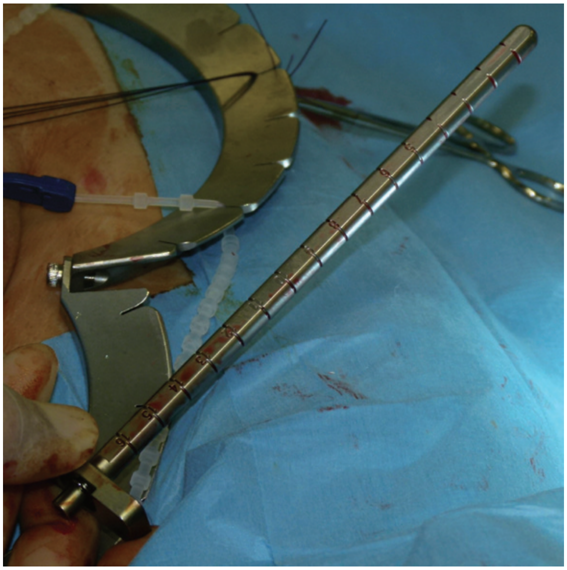

Figure 7.16 A Furlow measurer is used to measure the length of the distal and proximal corpora. This will gauge the length of the cylinders required for implantation.

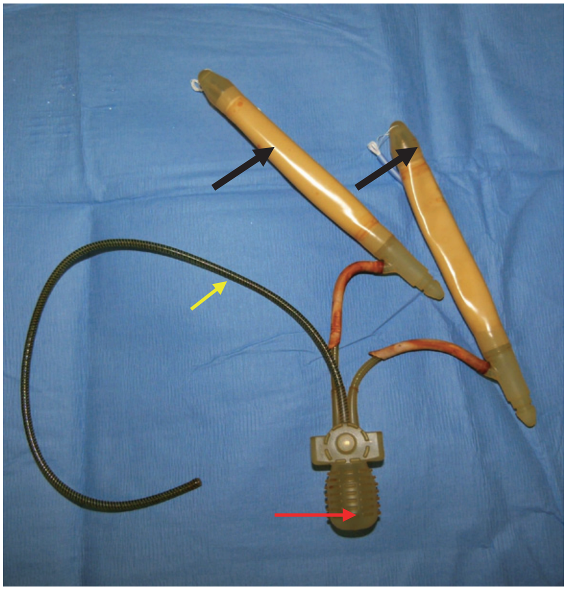

Figure 7.17 An AMS 700CX™ is shown demonstrating the cylinders (black arrows), momentary squeeze pump (red arrow) and exit tubing (yellow arrow).

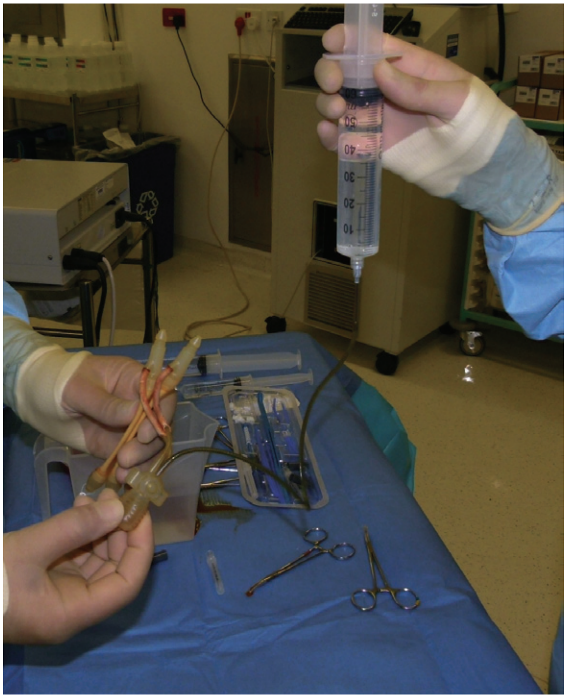

Figure 7.18 The air is expelled from the implant cylinders and tubing. Isotonic normal saline is used to fill the pump and cylinders and expel any excess air bubbles by squeezing the MS pump. The implant is deflated and rubber shods applied to the tubing.

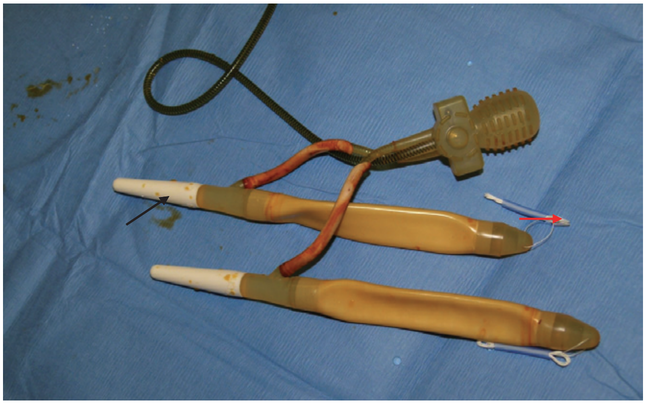

Figure 7.19 Depending on the corporal measurements, rear tip extenders (black arrow) are placed on the cylinders to match the size of the corporal measurements using the Furlow. Preplaced sutures (red arrow) are mounted on the Furlow using a needle and aid the positioning of the cylinder tips under the glans.

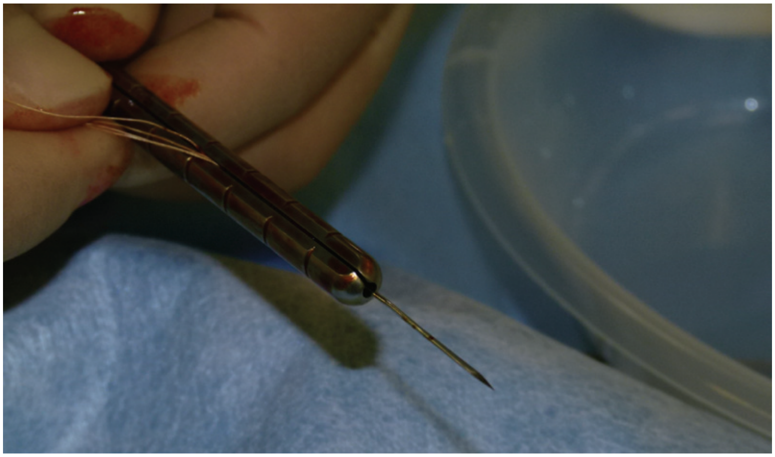

Figure 7.20 As part of the accessory kit a lightning bolt needle is provided to allow the sutures from the distal ends of the cylinders to be placed through the eye of the needle. This is then mounted on to the Furlow.

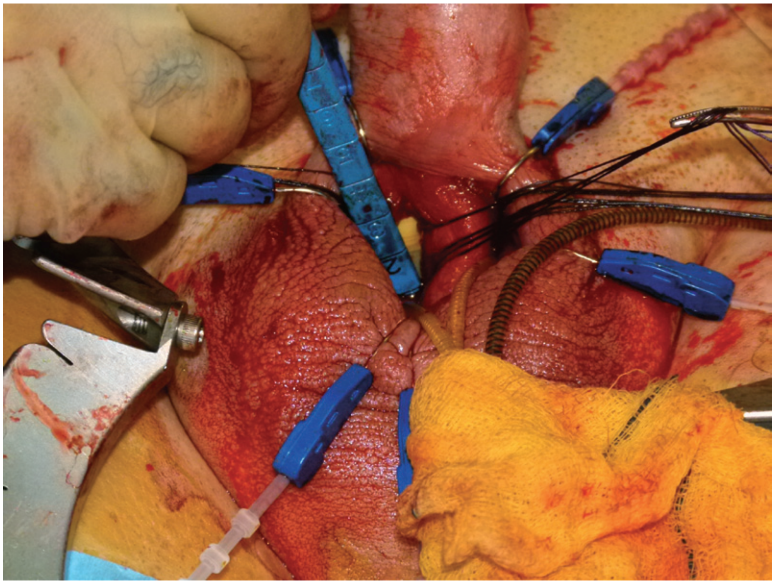

Figure 7.21 The proximal end of the cylinder is placed into the proximal crura and gently pushed down.

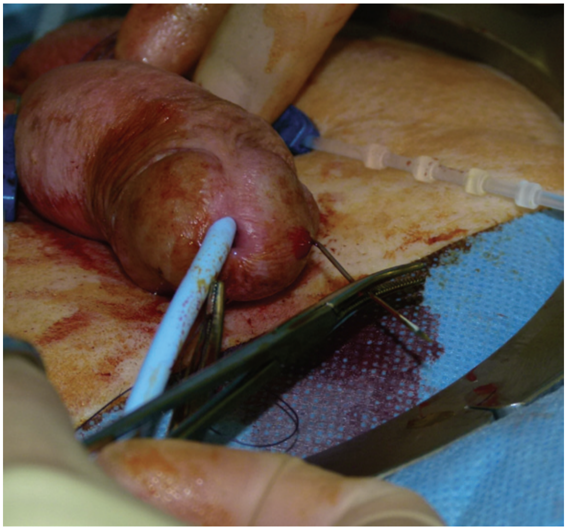

Figure 7.22 Distally a pusher is inserted into the Furlow and the needle is advanced through the mid glans. The sutures on the cylinder tips can then be pulled through ensuring that the cylinders fill the full length of the corpora. Before closing the corporotomies the cylinders are inflated by attaching the tubing to a 60 mL syringe of saline and squeezing the MS pump to ensure that the cylinders do not bulge out of the corporotomies.

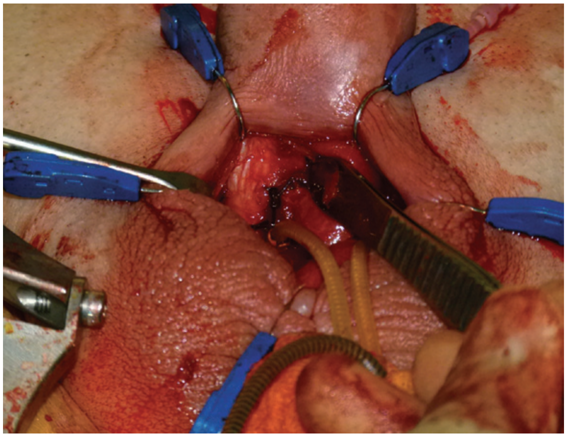

Figure 7.23 The stay sutures on either side of the corporotomy are tied over. The jackets covering the exit tubing are also removed.

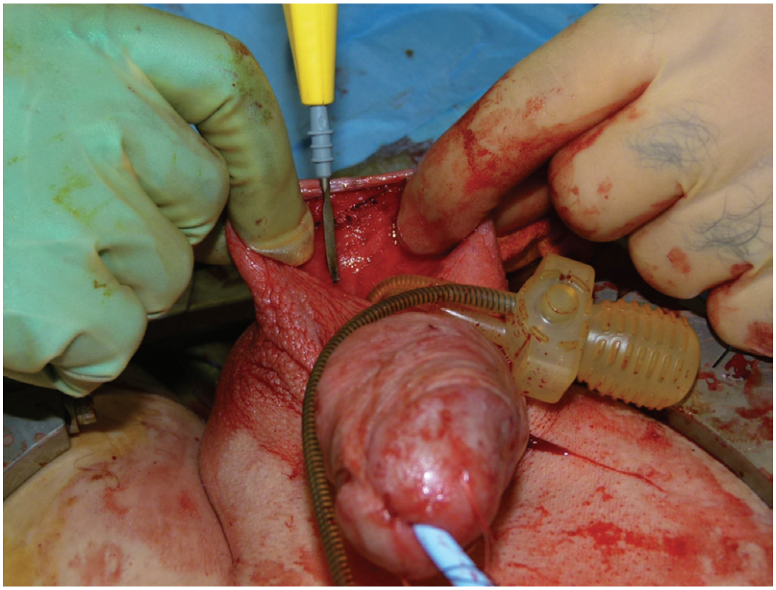

Figure 7.24 The MS pump is inserted into a sub-dartos pouch in the scrotum. The neck of the pouch can be closed using a purse-string suture.

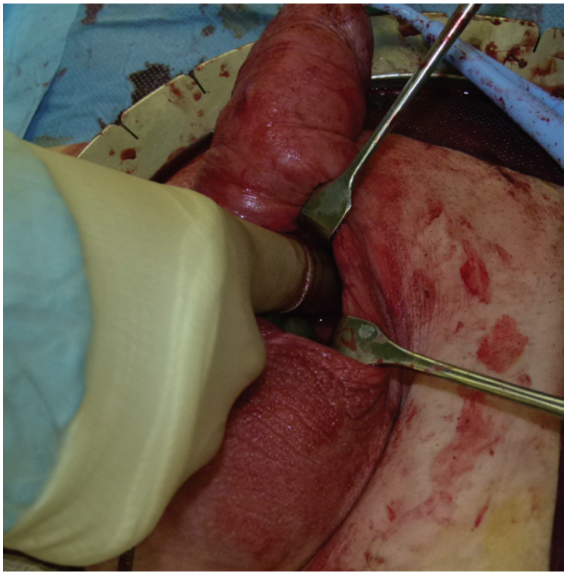

Figure 7.25 The bladder is emptied via the urethral catheter. Blind insertion of the reservoir is performed by first identifying the superficial inguinal ring and the pubic tubercle. In cases where previous pelvic surgery (e.g. radical prostatectomy) has been performed, open insertion of the reservoir into the space of Retzius is safer. Metzenbaum scissors are inserted medial to the spermatic cord and through the transversalis fascia.

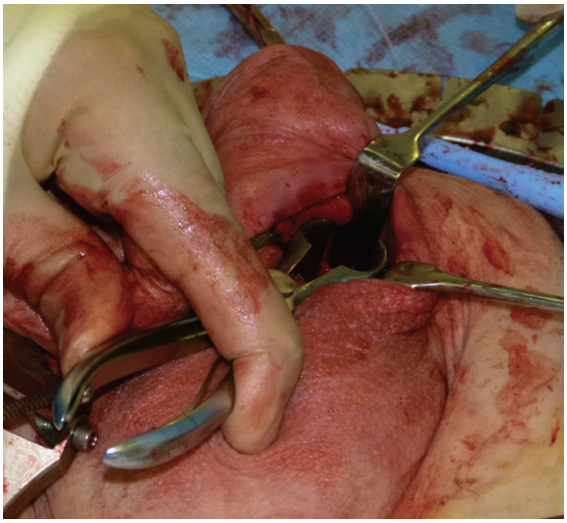

Figure 7.26 A nasal speculum is inserted into the space of Retzius. The reservoir can then be inserted into the retropubic space and filled with either 65 or 100 mL saline depending on the size of the reservoir.

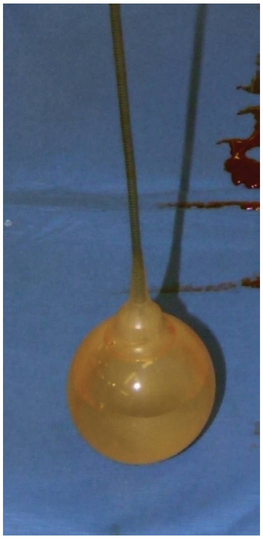

Figure 7.27 The reservoir is filled with normal saline and the air is removed prior to placement through the superficial ring.

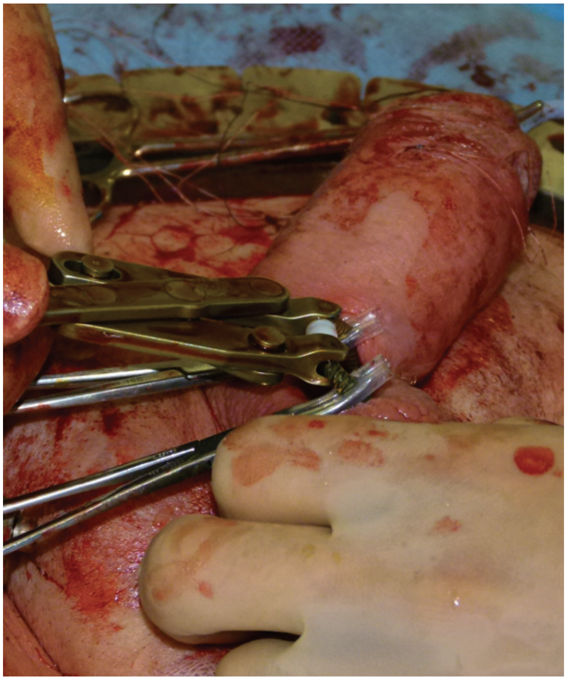

Figure 7.28 Connectors are used to attach the tubing from the pump to the reservoir.

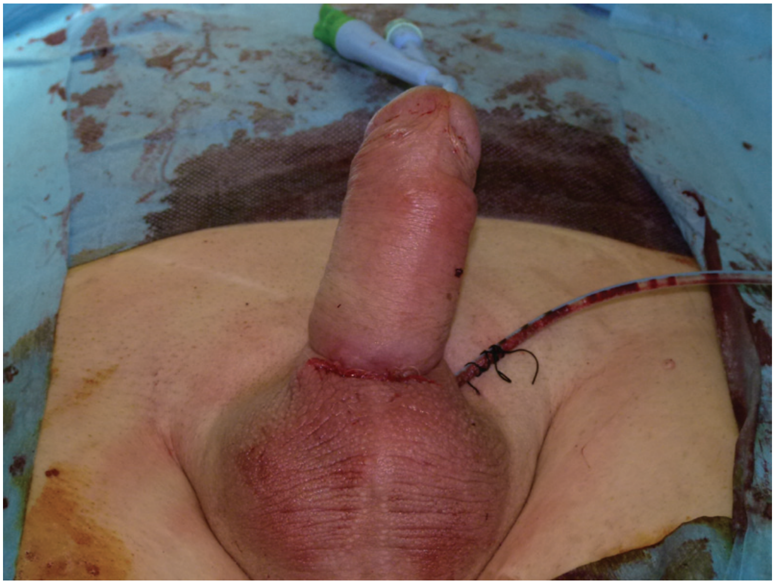

Figure 7.29 A suction drain is optional. The dartos is closed in layers. Interrupted polyglactin sutures are used to close the skin.

Intraoperative trouble shooting

A number of problems can arise during implant surgery. Although the overall risk is low, it is significantly higher in patients with marked corporal fibrosis, and more care must be taken during corporal dilatation in such cases. Early recognition intraoperatively provides the best opportunity for immediate correction, and reduces the risk of subsequent infection or revision.

Urethral perforation

Distal urethral perforation is usually recognized intraoperatively by blood at the urethral meatus, or efflux of antibiotic irrigant from the meatus during intracorporal washout after dilatation. It is important to locate the leak, and repair the urethra with a suitable absorbable 4-0 or 5-0 polyglactin suture. The corpora should be thoroughly washed out again with antibiotic solution, and the wound treated as contaminated. In this circumstance, the safest approach is to abandon the operation if the perforation has occurred early in the procedure. If the site of injury cannot be located, a catheter should be left *in situ* for 2 weeks. A pericatheter urethrogram can be performed before removal of the catheter to ensure adequate healing of the urethra.

Cylinder crossover

This may be missed intraoperatively, but can be detected when checking the distal corporal space with the dilators. Instead of sitting parallel and lying equally under the glans on both sides, the dilators will be found to cross the midline to sit in the opposite corporal tip. Postoperatively this may manifest as an unusual appearance, with either a twisted or tilted penis and prosthesis, or with no palpable prosthesis distally on one side. If recognized intraoperatively, a dilator should be left in the correctly dilated distal corpora and redilatation of the opposite corpora should be performed. An MRI scan can help detect crossover in delayed presentations (Figure 7.30).

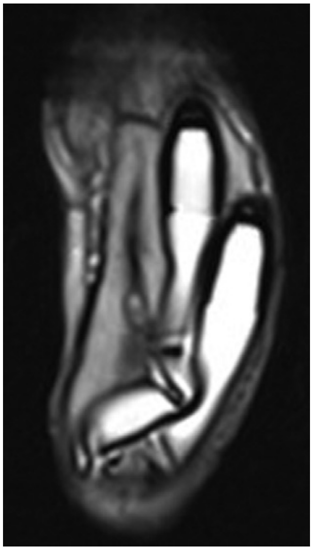

Figure 7.30 Penile magnetic resonance imaging (MRI) scan demonstrating cylinder crossover which was detected postoperatively.

Posterior crural perforation

This complication is readily recognizable intraoperatively. A sudden loss of resistance during proximal corporal dilatation raises the possibility of crural perforation. This can be confirmed when dilators are placed proximally on both sides simultaneously. A large discrepancy will be immediately obvious on the side of the perforation. If a malleable prosthesis is being inserted, it may be possible to simply suture the cylinder to the tunica albuginea during closure with an 0 PDS™ suture to prevent migration. The patient should refrain from bending the device for the first 4 weeks postoperatively to allow the defect to heal, and a capsule to adequately form around the prosthesis. If an inflatable prosthesis is being inserted then one option is to use a Dacron® or Gore-Tex® "sock" to sit over the heel of the prosthesis. This can be sutured to the tunica albuginea to keep the cylinder in place. Alternatively a "hitch stitch" is used through the tip of the rear tip extender and sutured to the edge of the corporotomy. The cylinder is then inflated keeping the distal tip on tension and the suture is then tied. A capsule is then allowed to form around the rear tip extender. The advantage of this technique is that it avoids the use of Dacron® and therefore reduces the risk of subsequent infection. If a posterior crural perforation occurs then patients are advised not to use the prosthesis for sexual intercourse for 3 months.

Surgical tips for difficult cases

Extensive corporal fibrosis

The extensive fibrosis secondary to priapism or a previous implant infection results in a scarred corpora which is difficult to dilate. With the aid of Rosello dilators, a channel can be created with the addition of multiple corporotomies. Narrow cylinders such as the Coloplast Titan® narrow base or AMS CXR cylinders can be inserted in the limited space. These expand the space over time to allow for a delayed exchange to upsized cylinders. In cases where the space created by dilatation is insufficient to allow closure of the corporotomy, additional graft material can be used to cover the implant. Graft material ranging from Gore-Tex® and Tutoplast® to autologous rectus fascia have been used with reasonable success.

An alternative approach in patients with prolonged ischemic priapism is to insert a penile prosthesis early (within days or a few weeks), prior to the onset of marked fibrosis. This has the advantage of treating the refractory priapism and preventing additional loss of penile length and girth secondary to established fibrosis. When performing the surgery acutely, corporal dilatation can be performed with relative ease (Figures 7.31, 7.32, 7.33 and 7.34).

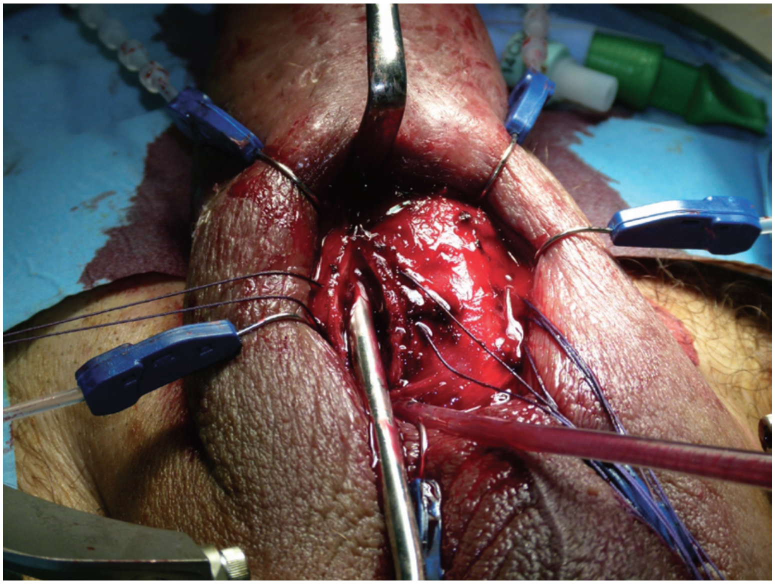

Figure 7.31 Corporal dilatation in a case of refractory ischemic priapism 72 hours after the onset of the erection. The corporotomies can be performed slightly higher on the shaft compared with the inflatable implants. Despite smooth muscle necrosis the dilatation is relatively straightforward.

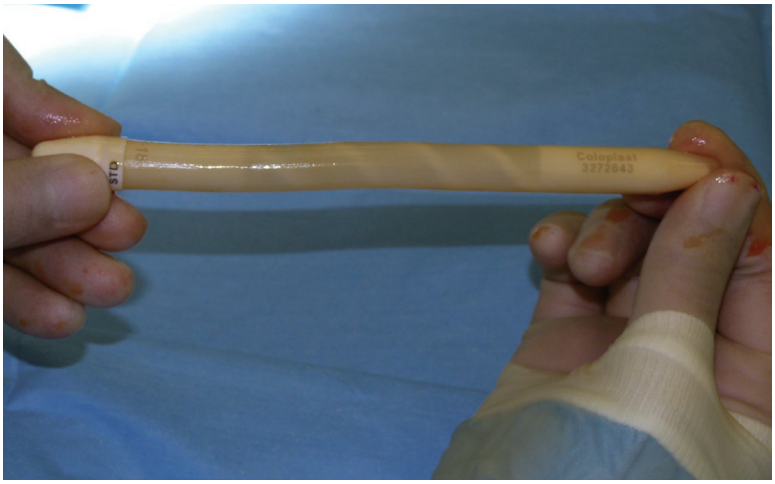

Figure 7.32 A Genesis$^{\text{TM}}$ malleable prosthesis is used using a standard rear tip extender.

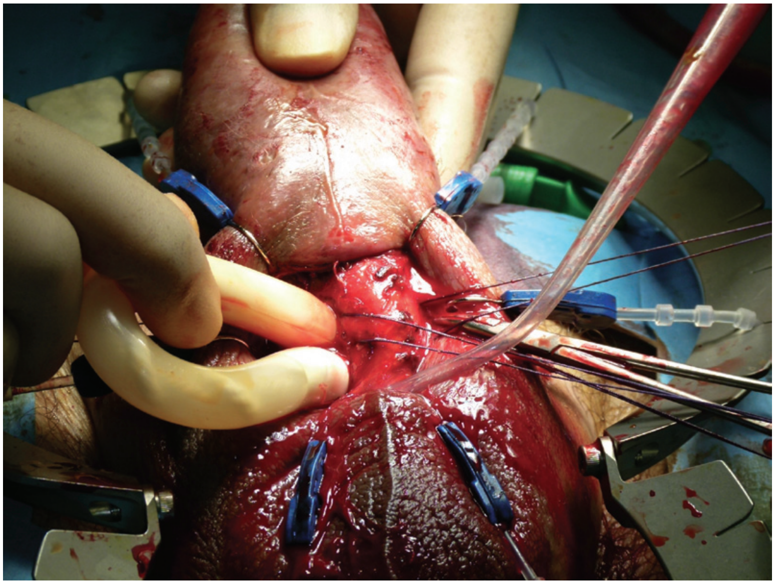

Figure 7.33 The penile shaft is supported posteriorly as the malleable implant is inserted into the corpora.

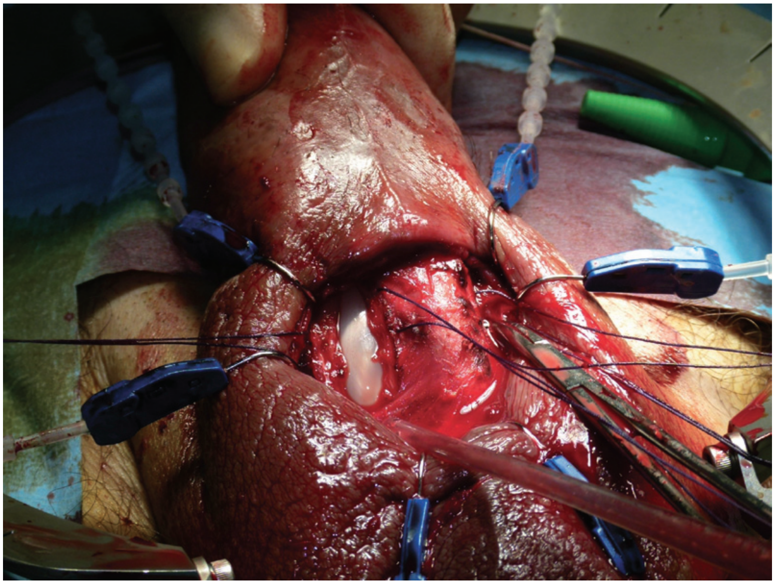

Figure 7.34 Malleable implant inserted and in position. The corporotomies are closed using 0 polyglactin sutures as a continuous closure.

Peyronie's disease

Both malleable and inflatable implants have important roles in the management of Peyronie's disease associated with erectile dysfunction refractory to PDE-5 inhibitors. The selection of the most appropriate device is largely dependent on the patient's desires. For patients with a curvature greater than 30°, insertion of an inflatable penile prosthesis can be combined with penile modeling (Figure 7.35). This involves inserting and fully inflating the penile prosthesis, then placing double shod clamps on the exit tubing from the cylinders to prevent excessive back pressure to the pump, before manually bending the penis to straighten the residual curvature. The penis should be bent for approximately 90 seconds, and should not be bent dorsally to prevent inadvertent urethral rupture.

If modeling is unsuccessful, tunical plication or grafting can still be performed to achieve a straight penis. Small residual curvatures of <20° do not require surgical correction, and may further improve with simple cycling of the inflatable device over a 6-month period.

Subsequent studies have reported an increased risk of inflatable implant malfunction associated with modeling. DiBlasio *et al*. reported a 33% malfunction rate for implants inserted in patients with Peyronie's disease with modeling, compared with only 4% in cases with no Peyronie's disease or modeling.

An alternative approach is to perform a plaque incision, or partial excision, and grafting procedure combined with insertion of a malleable penile prosthesis through the incised tunica. This approach allows both complete penile straightening and restoration of lost length as a consequence of Peyronie's disease.

Managing postoperative complications

The infected implant

Delayed removal of an infected prosthesis increases the risk of implant erosion which may be seen as cylinder erosion through the corporal tips or pump erosion through the scrotum. In cases where there is diagnostic doubt, a T2 weighted MRI scan of the penis can be useful to demonstrate fluid around the components (Figures 7.36 and 7.37).

Swabs should be taken preoperatively to ensure an appropriate antibiotic regimen is used. Prosthesis removal should be accompanied with a strict washout protocol

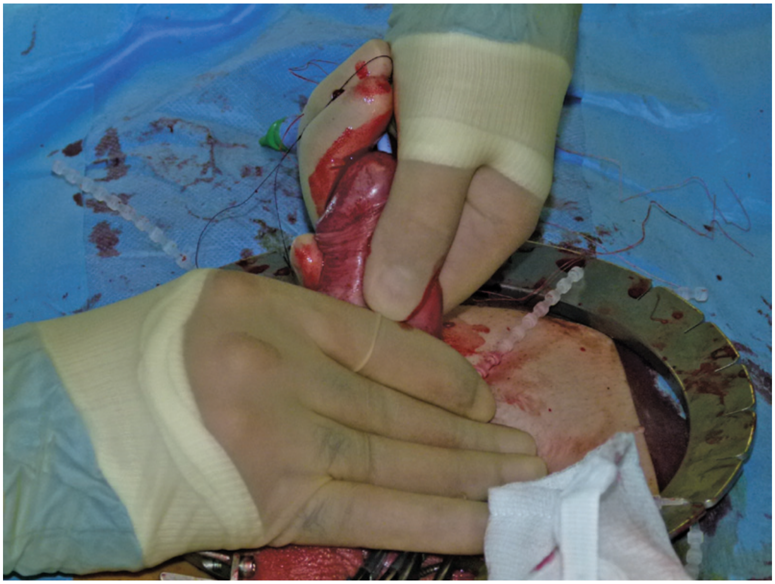

Figure 7.35 Demonstration of penile modeling of a dorsal curvature following insertion of an inflatable prosthesis. The urethra and corporotomies must be supported.

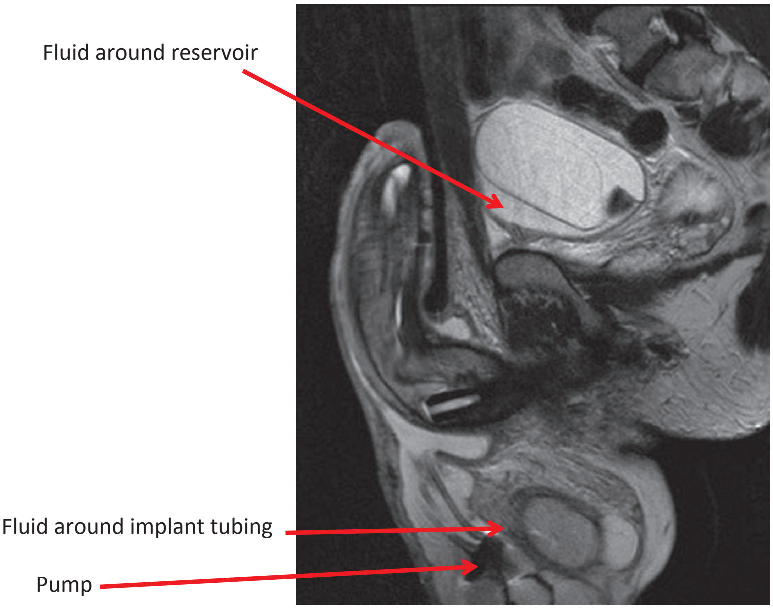

Figure 7.36 T2 weighted MRI scan demonstrating features in keeping with infection of the penile prosthesis.

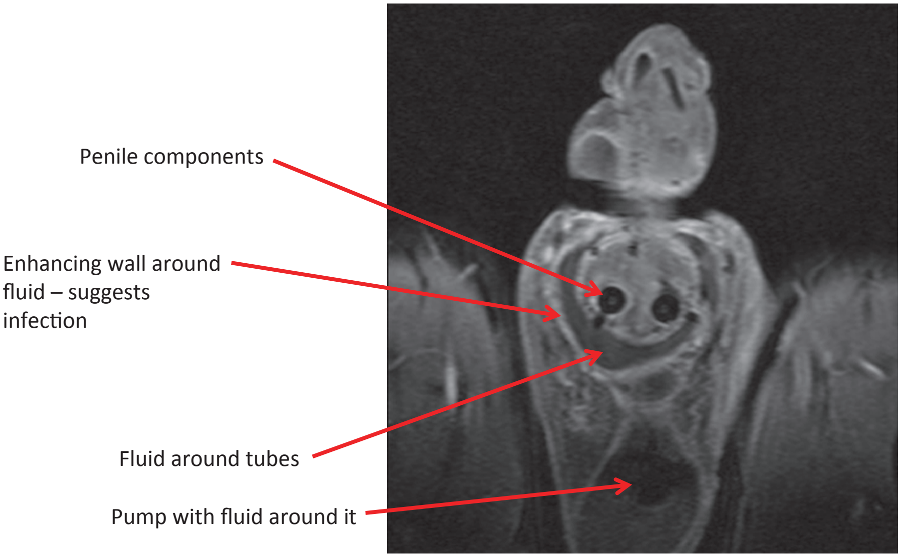
Penile components
Enhancing wall around fluid – suggests infection
Fluid around tubes
Pump with fluid around it

Figure 7.37 Post contrast T1 coronal MRI scan demonstrating features consistent with implant infection.

Table 7.3 Mulcahy salvage protocol

1. Antibiotic solution
2. Half strength hydrogen peroxide
3. Half strength betadine solution
4. Pressure wash with irrigant containing 1 g vancomycin and 80 mg gentamicin
5. Half strength betadine solution
6. Half strength hydrogen peroxide
7. Antibiotic solution

as described by Mulcahy (Table 7.3). This regime uses a protocol of seven antibacterial solutions, delivered with pressure to remove the colonizing bacteria and biofilm. This can be combined with an immediate "salvage" reinsertion of a new prosthesis in selected cases. An immediate reinsertion should be avoided in patients with poorly controlled diabetes, signs of impending erosion or signs of severe infection (skin necrosis or if systemically unwell). It should also be avoided in the presence of unusually resistant bacteria such as MRSA. If used judiciously, immediate reinsertion has a long-term success rate of 82% and avoids the risk of reinsertion into densely scarred and fibrotic corpora. After salvage, patients should continue on oral antibiotic treatment for up to 4 weeks. If immediate reinsertion cannot be performed, the same washout protocol should be employed, but corrugated drains should be placed into the penoscrotal and abdominal wounds to ensure complete drainage of any infected fluid in the immediate postoperative period. A delayed reinsertion should be planned after a period of at least 6 months, and the patient warned of the likely loss of penile length and girth as a result of the ensuing fibrotic process.

Mechanical failure

In this situation, the tubing should be exposed, inspected and tested for leaks. If there is evidence of a leak, then this component of the prosthesis can be replaced. Most often the leak lies between the cylinders and the pump. If a leak is not detected, the pump should be exteriorized and tested. If pump failure per se is diagnosed, it can be exchanged for a new one. If the prosthesis is approaching its expected lifespan, it is more sensible to exchange the entire device.

Autoinflation occurs due to excessive fluid in the system, failure of the lock-out valve or increased pressure on the reservoir. The tubing leading to the reservoir can be isolated and the volume and back pressure in the reservoir assessed. This will then determine whether the reservoir should be resited or replaced or whether a capsulotomy is all that is required.

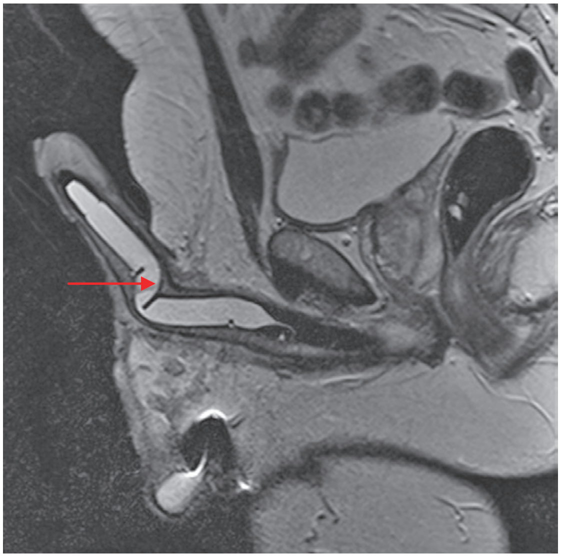

Figure 7.38 MRI demonstrating "S"-shaped deformity of cylinders due to incorrect sizing of the implant.

Incorrect sizing of the cylinders can result in an "S"-shaped deformity leading to implant malfunction. In this situation it is advisable to remove the implant and downsize the cylinders (Figure 7.38).

Managing implant erosion

For distal erosion, a hemi-circumferential sub-coronal incision can be used to expose the corporal tip on the side of the erosion. The tip of the cylinder is then removed, and the eroding tunical defect closed with polydiaxanone sutures. The cylinder can then be replaced, and the corpora, dartos and skin closed in layers.

In cases of lateral erosion, it is necessary to redirect the eroding cylinder back to its original position. This entails exposure of the cylinder, usually through a ventral vertical incision or hemi-circumferential sub-coronal incision, depending on the extent of erosion. The posterior aspect of the cylinder's capsule is incised using cutting diathermy, and a new channel created using Metzenbaum scissors and dilators. The cylinder is then re-routed into its new position, and the old capsule and overlying corpora are closed as two layers to prevent further erosion.

Surgery for SST deformity

If there is inadequate dilatation of the distal corpora then this can be redilated and the cylinders upsized. If no abnormality is found on imaging and the issue is of concern to the patient, or causes discomfort to the partner, a glanspexy can be performed. This involves making a hemi-circumferential sub-coronal incision, followed by partial dissection of the glans cap off the corpora, towards the apex of the corporal tips, avoiding the dorsal neurovascular bundle. Once this is achieved, the glans cap may be re-positioned on the corporal tips using paired 4-0 polydiaxanone sutures to hitch the underside of the glans to the corporal tips, and secured with paired polydiaxanone sutures on both sides between the underside of the glans, and the corporal tips.

Postoperative care

Patients undergoing an inflatable prosthesis are kept in hospital overnight with the implant partially inflated. Those with malleable prostheses can be discharged the same day. For those with inflatable devices, the dressing is removed the following morning, the catheter removed and the device fully deflated prior to discharge. Patients are followed up 2 weeks postoperatively for assessment, and for teaching on how to cycle the device. Patients are again reviewed at 6 weeks prior to commencement of intercourse. Patients with malleable devices are seen at 3 and 6 weeks postoperatively, at first to be assessed and instructed to bend the device, and subsequently for a final check before resumption of sexual activity.

Conclusions

Penile prostheses have stood the test of time, and provide a safe and reliable method for the treatment of several problems, ranging from refractory ischemic priapism and Peyronie's disease with ED, to refractory ED. Surgery in high volume centers allows for development of expertise to deal with any eventuality and is associated with the best outcomes. Rapid postoperative access to a dedicated specialist team nurse provides the ideal approach to the early detection and management of any complications. Careful preoperative counseling and involvement of the patient in selecting the right type of prosthesis is essential to effectively manage patient's expectations, which will ultimately result in the highest rate of satisfaction.

Further reading

Carson CC 3rd. Efficacy of antibiotic impregnation of inflatable penile prostheses in decreasing infection in original implants. J Urol 2004;171(4):1611–4.

Carson CC, Mulcahy JJ, Govier FE. Efficacy, safety and patient satisfaction outcomes of the AMS 700CX inflatable penile prosthesis: Results of a long-term multicenter study. AMS 700CX Study Group. J Urol 2000;164(2):376–80.

Carson CC 3rd, Mulcahy JJ, Harsch MR. Long-term infection outcomes after original antibiotic impregnated inflatable penile prosthesis implants: up to 7.7 years of followup. J Urol 2011;185(2):614–8.

Dhabuwala C, Sheth S, Zamzow B. Infection rates of rifampin/gentamicin-coated Titan Coloplast penile implants: Comparison with Inhibizone-impregnated AMS penile implants. J Sex Med 2011;8(1):315–20.

Dhar NB, Angermeier KW, Montague DK. Long-term mechanical reliability of AMS 700CX/CXM inflatable penile prosthesis. J Urol 2006;176(6 Pt 1):2599–601.

DiBlasio CJ, Kurta JM, Botta S, Malcolm JB, Wan JY, Derweesh IH, et al. Peyronie's disease compromises the durability and component-malfunction rates in patients implanted with an inflatable penile prosthesis. BJU Int 2010;106(5):691–4.

Flores S, Choi J, Alex B, Mulhall JP. Erectile dysfunction after plaque incision and grafting: Short-term assessment of incidence and predictors. J Sex Med 2011;8(7):2031–7.

Garaffa G, Minervini A, Christopher NA, Minhas S, Ralph DJ.The management of residual curvature after penile prosthesis implantation in men with Peyronie's disease. BJU Int 2011;108(7):1152–6.

Gorbatiy V, Westney OL, Romero C, Wang R. Outcomes of simultaneous placement of an inflatable penile prosthesis and a male urethral sling through a single perineal incision. J Sex Med 2010;7(2 Pt 1):832–8.

Kendirci M, Gupta S, Shaw K, Morey A, Jones L, Hakim L, et al. Synchronous prosthetic implantation through a transscrotal incision: an outcome analysis. J Urol 2006;175(6):2218–22.

Kim DS, Yang KM, Chung HJ, Choi HM, Choi YD, Choi HK. AMS 700CX/CXM inflatable penile prosthesis has high mechanical reliability at long-term follow-up. J Sex Med 2010;7(7):2602–7.

Knoll LLD, Furlow WL, Benson RC Jr, Bilhartz DL. Management of nondilatable cavernous fibrosis with the use of a downsized inflatable penile prosthesis. J Urol 1995;153:366–7.

Knoll LLD. Use of penile prosthetic implants in patients with penile fibrosis. Urol Clin North Am 1995;22:857–63.

Kulmala RV, Tamella TJL. Effects of priapism lasting 24 h or longer caused by intracavernosal injection of vasoactive drugs. Int J Imp Res 1995;7:131–6.

Lux M, Reyes-Vallejo L, Morgentaler A, Levine LA. Outcomes and satisfaction rates for the redesigned 2-piece penile prosthesis. J Urol 2007;177(1):262–6.

Mancini JG, Kizer WS, Jones LA, Mora RV, Morey AF. Patient satisfaction after dual implantation of inflatable penile and artificial urinary sphincter prostheses. Urology 2008;71(5): 893–6.

Minervini A, Raplh DJ, Pryor JP. Outcome of penile prosthesis implantation for treating erectile dysfunction: Experience with 504 procedures. BJU Int 2005;97:129–33.

Montague DK, Angermeier KW. Corporeal excavation: new technique for penile prosthesis implantation in men with severe corporeal fibrosis. Urology 2006;67:1072–5.

Montorsi F, Rigatti P, Carmignani G, Corbu C, Campo B, Ordesi G, et al. AMS three-piece inflatable implants for erectile dysfunction: A long-term multi-institutional study in 200 consecutive patients. Eur Urol 2000;37(1):50–5.

Mulcahy JJ. Long-term experience with salvage of infected penile implants. J Urol 2000;163(2):481–2.

Palese MA, Burnett AL. Corporoplasty using pericardium allograft (tutoplast) with complex penile prosthesis surgery. Urology 2001;58:1049–52.

Pathak AS, Chang JH, Parekh AR, Aboseif SR. Use of rectus fascia graft for corporeal reconstruction during placement of penile implant. Urology 2005;65:1198–201.

Rajpurkar AA, Li HH, Dhabuwala CCB. Penile implant success in patients with corporal fibrosis using multiple incisions and minimal scar tissue excision. Urology 1999;54:145–7.

Ralph DJ, Garaffa G, Muneer A, Freeman A, Rees R, Christopher AN, et al. The immediate insertion of a penile prosthesis for acute ischaemic priapism. Eur Urol 2009;56: 1033–8.

Salem EA, Wilson SK, Neeb A, Delk JR, Cleves MA. Mechanical reliability of AMS 700 CX improved by parylene coating. J Sex Med 2009;6(9):2615–20.

Sellers CL, Morey AF, Jones LA. Cost and time benefits of dual implantation of inflatable penile and artificial urinary sphincter prosthetics by single incision. Urology 2005;65(5): 852–3.

Shaeer O, Shaeer A. Corporoscopic excavation of the fibrosed corpora cavernosa for penile prosethesis implantation: optical corporotomy and trans-corporeal resection, Shaeer's technique. J Sex Med 2007;4:218–25.

Spycher MA, Hauri D. The ultrastructure of the erectile tissue in priapism. J Urol 1986;135:142–7.

Taylor FL, Abern MR, Levine LA. Predicting erectile dysfunction following surgical correction of Peyronie's disease without inflatable penile prosthesis placement: Vascular assessment and preoperative risk factors. J Sex Med 2012;9(1): 296–301.

Wilson SK, Delk JR 2nd. A new treatment for Peyronie's disease: modeling the penis over an inflatable penile prosthesis. J Urol 1994;152(4):1121–3.

Wilson SK, Delk JR 2nd, Mulcahy JJ, Cleves M, Salem EA. Upsizing of inflatable penile implant cylinders in patients with corporal fibrosis. J Sex Med 2006;3(4):736–42.

Wilson SK, Salem EA, Costerton W. Anti-infection dip suggestions for the Coloplast Titan Inflatable Penile Prosthesis in the era of the infection retardant coated implant. J Sex Med 2011;8(9):2647–54.

Wilson SK, Terry T, Delk JR. Improved implant survival in patients with severe corporal fibrosis: A new technique without necessity of grafing. J Urol 1995;153:359A.

8

Augmentation Procedures for the Penis

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Introduction

Dating back thousands of years and in a number of cultures, the penis symbolizes masculinity as well as strength, endurance and courage. Even in prehistoric cave dwellers the size of the penis equated to fertility and virility as well as strength. Therefore men continue to place emphasis on penis size, resulting in a demand for penile enhancement surgery.

Clinical features

While micropenis represents the only real indication for penile augmentation, patients will still seek augmentation surgery despite having a normal-sized and functioning penis. Micropenis is congenital and secondary to an endocrinopathy or underlying genetic disorder. In the postpubertal period the penis shape is entirely normal but the shaft, scrotum and glans are all reduced in size; both sexual and erectile dysfunction manifest in adulthood. In contrast, men with a short penis have a reduction in the erect length but generally have normal erections unless severe psychogenic issues arise.

Measurements of flaccid and stretched penile length gained from published large series report that the flaccid penile length is 5–13 cm (average 9 cm) and the stretched penile length is 7.5–17.5 cm (average 12.5 cm). Men who present with a flaccid length within the normal range but have a perception that the penis size is abnormal have penile dysmorphophobia. This subjective perception of a smaller penile size is partly the result of the individual looking at the penis from above and this can be further distorted by the presence of a suprapubic fat pad which can bury the base of the penis.

Assessment

Patients have to be counseled with regards to the realistic expectations of surgery. An increase in length of more than 2–4 cm is unrealistic because of the nature of the penile structure. The flaccid and stretched penile lengths are measured from the pubic symphysis to a fixed point such as the external urethral meatus or the coronal sulcus and the length is documented. Photographs should also be taken with consent prior to any intervention and kept in the patients' records and the preoperative erectile function documented. Patients who have penile dysmorphophobia should also be assessed by a psychiatrist or psychologist prior to undergoing surgery.

Surgical management

Before undertaking surgery, a conservative approach using penile stretching and vacuum devices should be performed. In some cases this may be all that is required. However, these devices require a prolonged period of use and patients have to be well motivated.

Patients who have an unrealistic expectation or those who have undergone psychiatric evaluation and deemed unsuitable to undergo surgery should not be operated upon. The dissatisfaction rate and subsequent litigation resulting from augmentation surgery is high.

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Augmentation surgery aims to increase the penile shaft length by exposing more of the penile shaft (suprapubic lipectomy) or advancing the penile shaft (V-Y plasty or suspensory ligament division). Girth enhancement is more difficult. Injectable materials (e.g. silicone, oils) are often attempted by nonmedical personnel but are associated with disastrous complications including skin necrosis, foreign body granuloma and severe penile lymphedema.

Risks

Alterations in the penile shape or penile lymphedema may occur. Provided that there is no disruption to the corpus cavernosum, erectile function should remain unchanged. Careful dissection in the region of the neurovascular bundle should be undertaken to prevent glans hypoesthesia particularly with procedures such as suspensory ligament division or repair.

Outcomes

The literature relating to cosmetic and functional outcomes of lipectomy as a single procedure is limited as abdominal and pelvic liposuction and lipectomy are usually carried out in combination with other augmentation procedures such as suspensory ligament division and penile girth enhancement.

Published series that analyze the increase in the penile length following suspensory ligament division are scarce and comparing the data is difficult as a result of the variable techniques of penile length measurement and differing surgical techniques. In a large series of 42 patients in which flaccid stretched penile length and patients' satisfaction were measured, Li *et al.* reported that, despite an average increase of length of 1.3 cm following suspensory ligament division and silicone buffer insertion, satisfaction rates were very low, suggesting that only a minority of patients benefit from this operation.

Patient preparation

Preoperative, postoperative and intraoperative photographs should be taken with the patient's consent and kept in the medical records. Documentation of the penile length (flaccid and stretched) should also be recorded.

All of the procedures described can be performed with the patient supine. The patient should be encouraged to use a vacuum device preoperatively and this can then continue postoperatively to maintain penile length.

Surgical techniques

Penile lengthening procedures

Suprapubic fat pad excision, abdominal lipectomy and liposuction

This technique, also known as apronectomy, excises the excess adipose tissue that covers the base of the penis. As a result more of the penile shaft is uncovered. This procedure is therefore only suitable for patients who present with a buried penis as a consequence of abundant pubic adiposity or a protruding abdomen (Figures 8.1, 8.2, 8.3, 8.4 and 8.5).

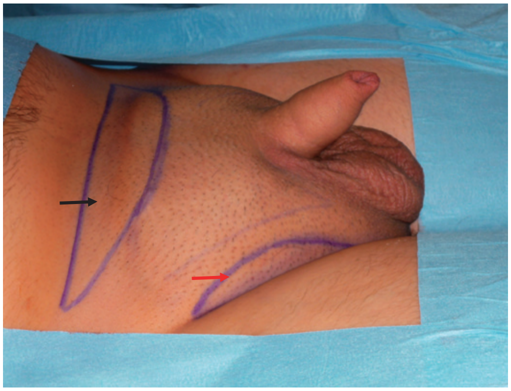

Figure 8.1 The suprapubic fat pad requiring excision is marked (black arrow). An additional ellipse of skin and fat can also be excised laterally to increase the prominence of the scrotum (red arrow).

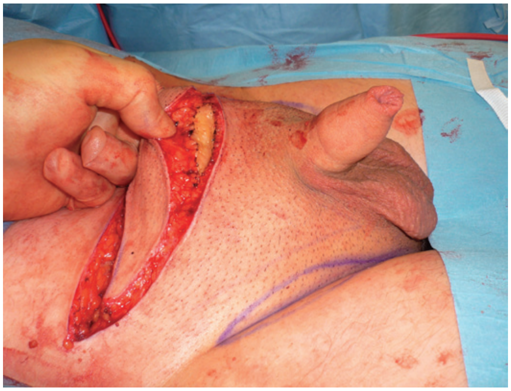

Figure 8.2 An incision through the skin and subcutaneous tissues is performed. Dissection continues down to the level of the rectus fascia.

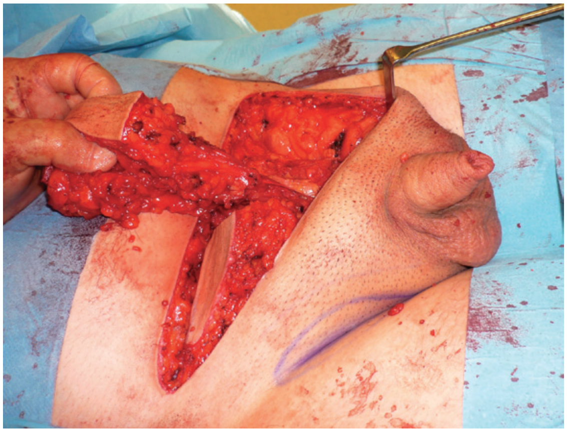

Figure 8.3 The skin and adipose tissue is excised. The adipose tissue under the lower flap is also removed. The lower skin flap should be thick enough to ensure that the vascularization is not compromised.

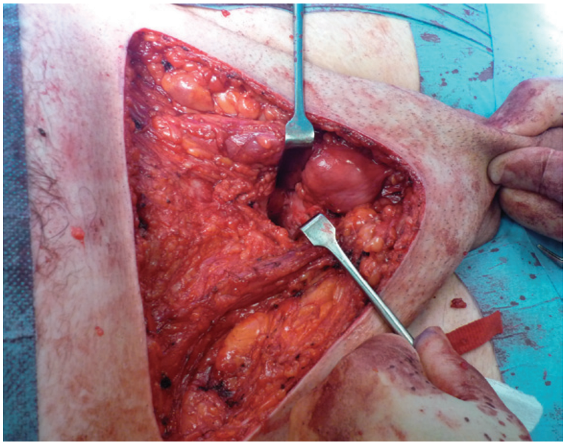

Figure 8.4 Traction on the lower skin flap demonstrates the penile base and also allows a suspensory ligament division to be performed.

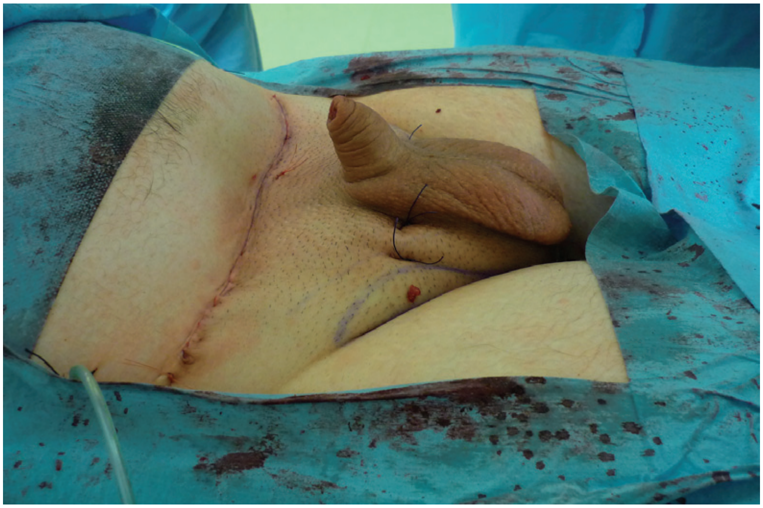

Figure 8.5 Suction drains are inserted to prevent postoperative seromas. The skin flaps are tacked to the rectus fascia to obliterate the space between the skin flaps and rectus fascia. The skin flaps are sutured with a layered closure of the subcutaneous tissue using 2-0 polyglactin sutures. For the skin closure 3-0 monofilament subcuticular sutures are used.

Abdominoplasty and abdominal lipectomy for buried penis

In cases where significant truncal obesity results in a buried penis, an abdominoplasty is performed. In the absence of extensive lichen sclerosus on the foreskin, this procedure is normally enough to allow the penis to be unburied (Figures 8.6, 8.7 and 8.8).

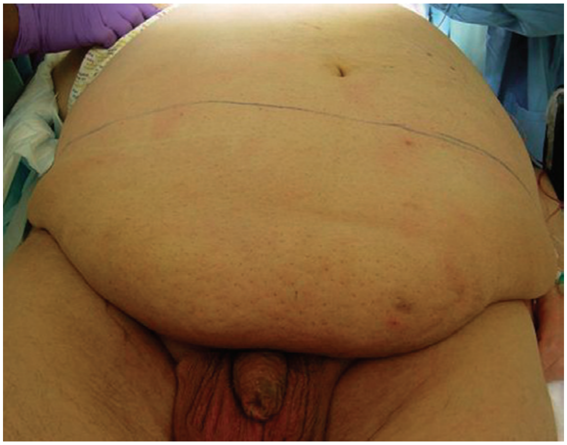

Figure 8.6 Patient with truncal obesity and a large pannus concealing the penis. The skin is marked to show the position of the incision required to remove the pannus.

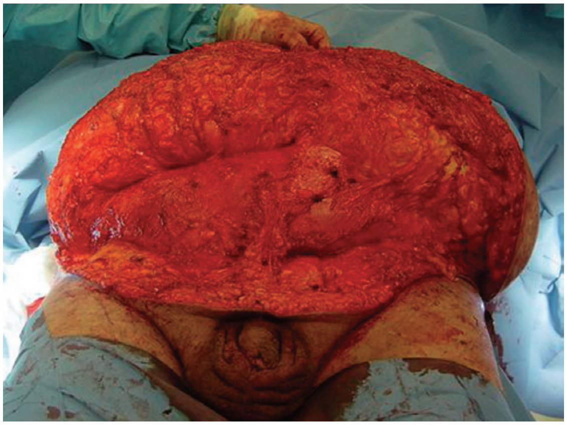

Figure 8.7 The apronectomy involves excising all of the excess skin and adipose tissue down to the level of the rectus fascia. The panniculus is pulled down and additional absorbable tacking sutures are placed subdermally in order to secure the abdominal and pubic skin to the rectus fascia.

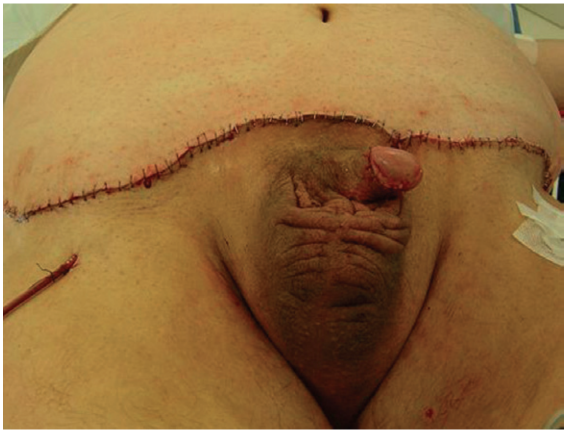

Figure 8.8 Suction drains are inserted bilaterally to reduce the risk of seroma formation. The subcutaneous layer is closed using 2-0 polyglactin sutures. The skin is closed with skin clips.

Suspensory ligament division

The penile ligament attachments are composed of the suspensory ligament which is an extension of the linea alba and a fibrous component termed the fundiform ligament (ligament of Luschka) which also provides ventral support to the penis. Division of the suspensory ligament from the pubic symphysis detaches the corpora cavernosa from the inferior pubic ramus and therefore increases the flaccid length. A silicone buffer or adipose tissue flap can be placed between the detached corpora and symphysis pubis in order to prevent the ligament from reattaching. Postoperatively, patients are warned that the angle of the penis with the abdominal wall will be altered and there is also instability at the base of the penis when it is erect (Figures 8.9, 8.10, 8.11, 8.12 and 8.13).

Postoperative care

Suspensory ligament division should always be followed by a program of penile traction in order to keep the base of the penis away from the pubic bone and to stretch the corporal bodies. Penile traction can be achieved with the aid of vacuum devices, traction devices or specialized weights that are hung from the coronal margin.

This procedure increases the visual length of the flaccid penis with no significant change in the erect state and therefore it is only indicated in patients with "locker room syndrome."

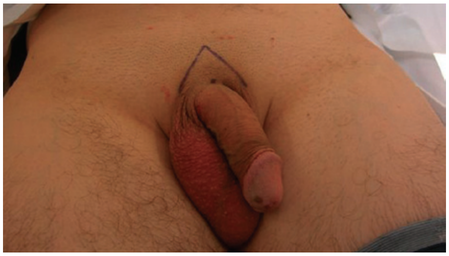

Figure 8.9 An inverted V incision is used to expose and identify the suspensory ligament.

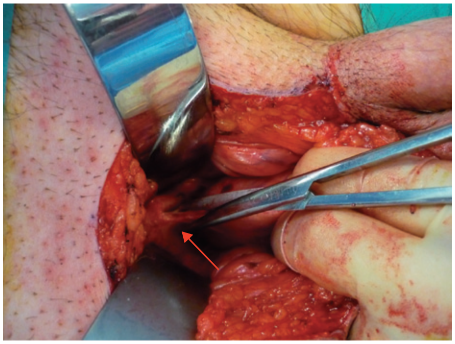

Figure 8.10 The suspensory ligament (red arrow) is identified and sharply divided keeping close to the pubic bone in order to avoid inadvertent damage to the dorsal neurovascular bundle.

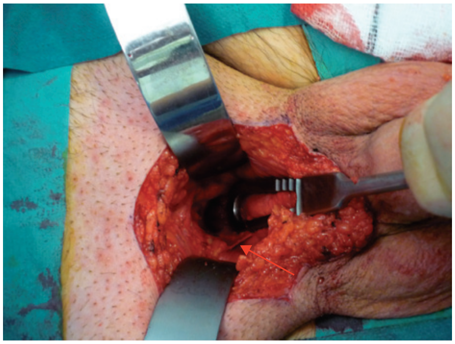

Figure 8.11 The suspensory ligament has been completely separated from the pubic bone (red arrow).

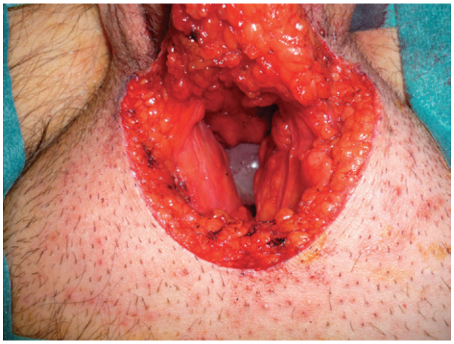

Figure 8.12 Readhesion of the ligament is avoided postoperatively by interposing a silicone buffer in the gap using either a vascularized suprapubic fat pad or silicone buffer.

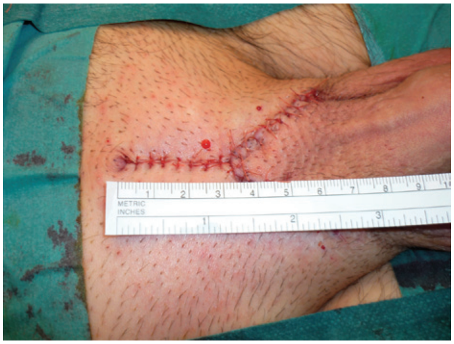

Figure 8.13 The incision is sutured in layers as an inverted Y achieving a penile length gain of 3 cm.

Suspensory ligament repair

Traumatic rupture of the suspensory ligament occurs during sexual intercourse and patients often report instability at the penile base and a loss of the acute angle between the penis and the anterior abdominal wall in the erect state (Figures 8.14, 8.15 and 8.16).

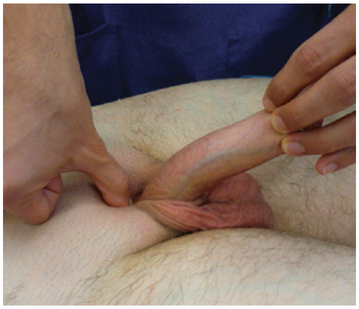

Figure 8.14 Palpating a gap below the symphysis pubis and penile base is in keeping with a defect in the suspensory ligament.

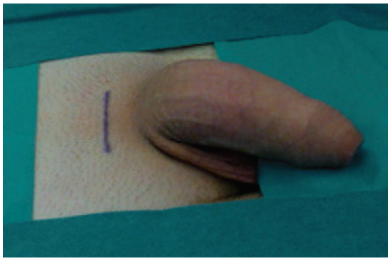

Figure 8.15 A transverse infrapubic incision is performed. Dissection through the subcutaneous tissues to the level of the suspensory ligament is performed. This is helped by using gentle traction on the penis.

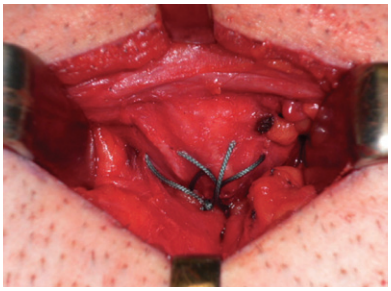

Figure 8.16 Once the defect is located 2-0 Ethibond sutures are used to fix the corporal bodies to the periosteum of the symphysis pubis. The sutures on the penis should be kept lateral to avoid injury to the neurovascular bundle.

Penile augmentation using skin advancement techniques

Penile augmentation using skin flaps is indicated when the penopubic skin "traps" the penis preventing its normal physiologic elongation during erection. This may be due to excessive skin loss following circumcision or conditions such as lichen sclerosus, genital lymphedema, penile trauma or burns.

The most common technique used is an inverted V-Y advancement flap, also known as a V-Y plasty, which can be combined with a suspensory ligament division (Figures 8.17 and 8.18). Alternative flaps include the lower abdominal Z plasty and the W flap reconstruction.

Surgical outcomes

One disadvantage of skin flaps is that they bring unattractive hair-bearing skin on to the penile shaft. Moreover, if poor wound healing occurs, skin flap contracture or skin necrosis at the apex may result in a buried penis or a 'bow string' effect, resulting in a penile curvature.

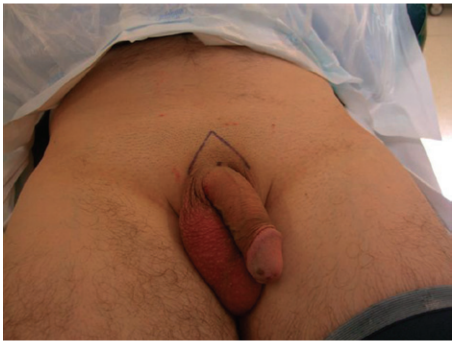

Figure 8.17 An inverted V flap is raised.

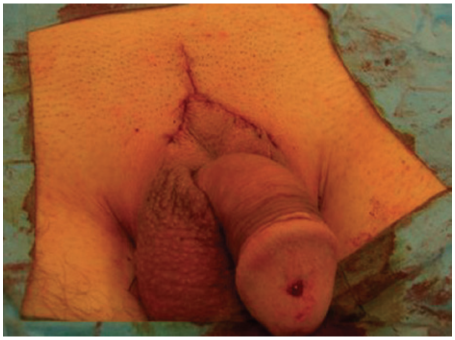

Figure 8.18 The flap is advanced and this procedure can be combined with a suspensory ligament division. The incision is closed as an inverted Y.

Skin grafting for penile reconstruction

Skin grafts can be used as an alternative to skin flaps to cover the penile shaft, especially in cases where the penile shaft has been unburied as a result of extensive lichen sclerosus. Full thickness skin grafts (FTSG) are preferred as they heal with less contracture than split thickness skin grafts (STSG), thus maintaining the elasticity of the penis necessary during erections. Any area with redundant, nonhairy skin can be used as a donor site with the groin crease, the axilla and the inner arm being the favored sites. Adequate preparation of the recipient site and of the skin graft are conditions sine qua non for an acceptable cosmetic and functional outcome. The graft must be adequately quilted to the recipient site and a compressive dressing applied to optimize graft take. In young patients erections can be inhibited pharmacologically by starting antiandrogen therapy 2 weeks preoperatively (Figures 8.19, 8.20, 8.21 and 8.22).

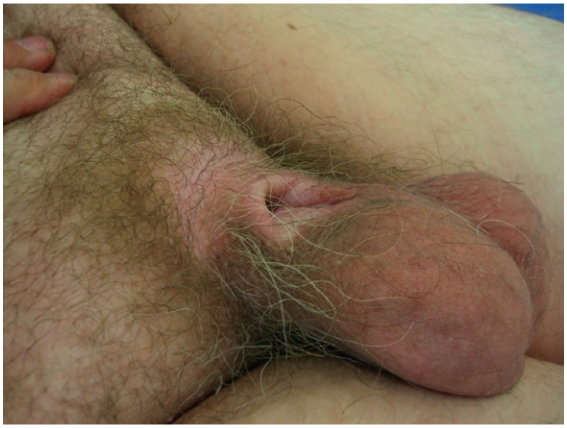

Figure 8.19 Buried penis in a patient with extensive lichen sclerosus. The lichen sclerosus gradually progresses to involve the adjacent scrotal skin.

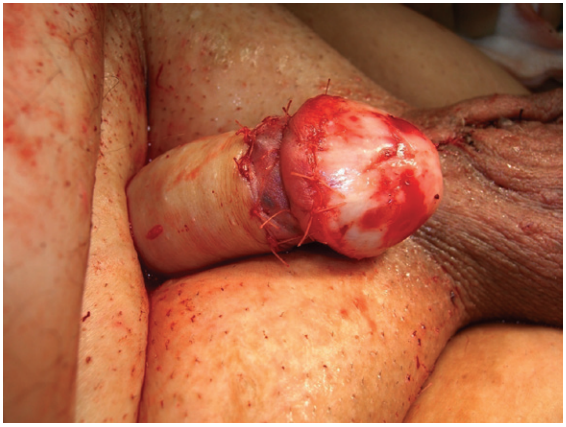

Figure 8.20 The penis is mobilized to expose the penile shaft and glans penis. Often there are extensive dartos bands that require division. The remaining dartos is sutured to the proximal penile shaft. A full thickness skin graft (FTSG) is sutured to the penile shaft. Extensive lichen sclerosus of the glans penis requires glans resurfacing with a split thickness skin graft (STSG).

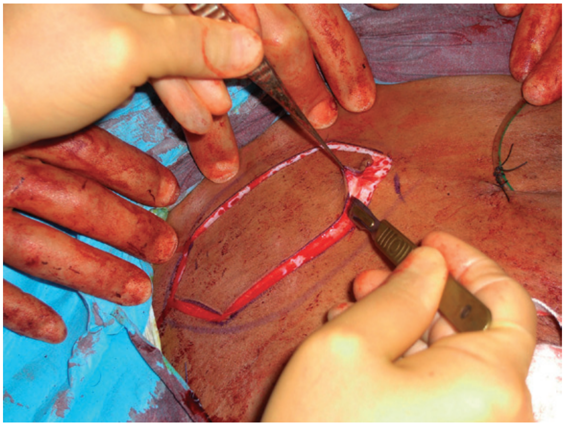

Figure 8.21 Demonstration of the technique to harvest the FTSG. The graft has to undergoing “defatting” before quilting to the penile shaft.

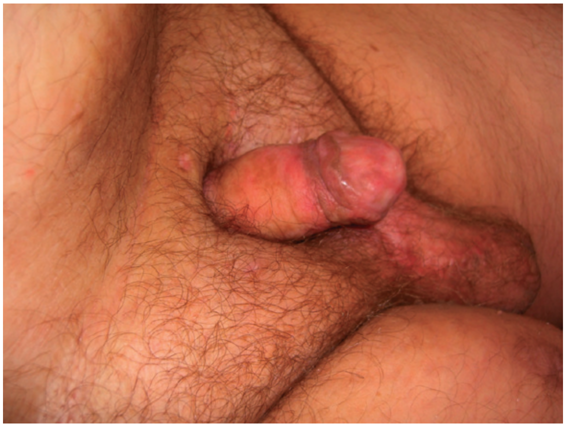

Figure 8.22 Final postoperative result.

Surgery for adult webbed penis

In cases of adult webbed penis, the penoscrotal junction is located on the penile shaft which is either congenital or secondary to a poor circumcision. This results in an apparent shortening of the length of the penile shaft and patients report tenting of the scrotal skin during erection. Excision of the web together with reconstruction of a new penoscrotal angle can be performed (Figures 8.23, 8.24, 8.25, 8.26 and 8.27).

Postoperative care

The skin sutures are removed after 14 days. Patients are advised to keep the penis elevated and dressings are applied to ensure that the penile shaft and scrotum do not remain apposed until the wound has fully healed.

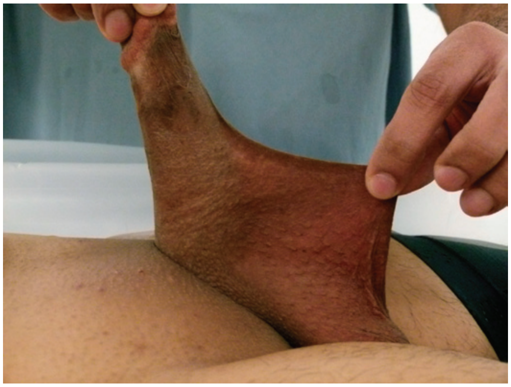

Figure 8.23 Demonstration of an adult webbed penis where the patient reports dissatisfaction of the penile shaft length and difficulty using a condom.

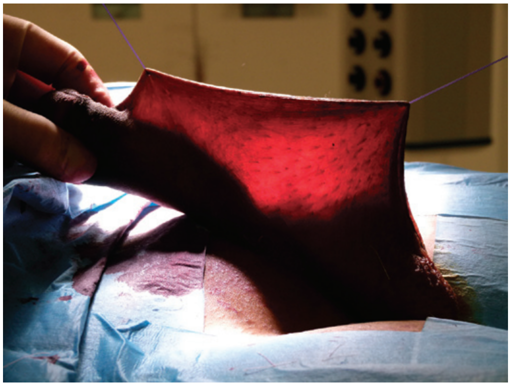

Figure 8.24 Transillumination of the skin allows visualization of the amount of skin that requires surgical excision and also the location of the new penoscrotal angle.

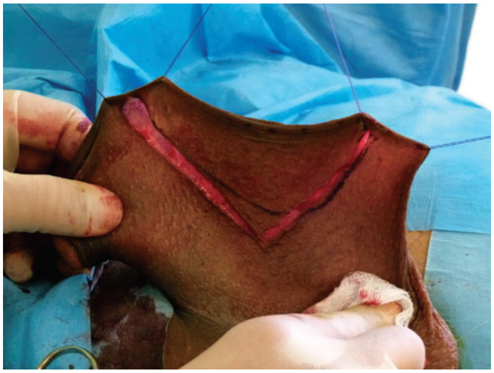

Figure 8.25 A wedge excision of the penoscrotal web is performed. Care is taken to ensure that there is enough shaft skin to allow tension-free closure on the ventral penile shaft.

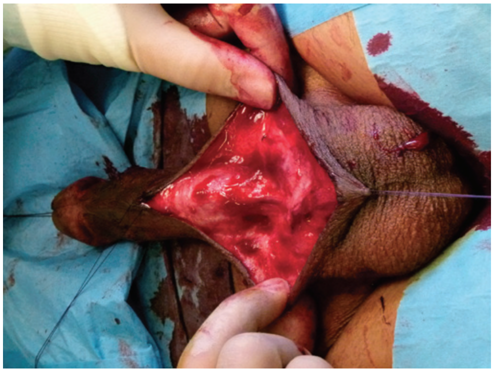

Figure 8.26 Web has been excised. The dartos layer at the penoscrotal junction is sutured using 3-0 or 4-0 polyglactin or PDS sutures to the tunica albuginea in order to create a new penoscrotal angle.

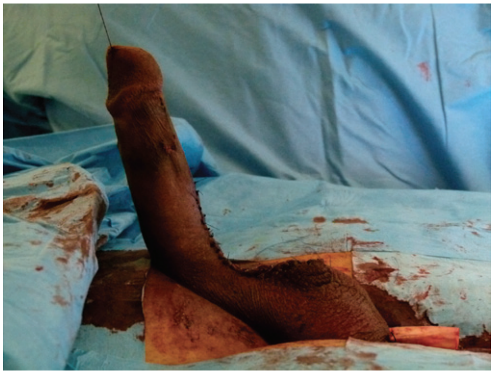

Figure 8.27 A new penoscrotal angle is created. A corrugated drain is inserted and brought out at the base of the scrotum. The skin is sutured using interrupted 4-0 nylon.

Penile girth enhancement surgery

Penile girth augmentation is controversial as it is only performed for aesthetic reasons. Although injection of various materials has been attempted, complications are high and the symmetry is poor.

Injectable materials

Fat injection

This procedure involves injecting adipose tissue into the dartos layer of the penis. Initially considered as a very promising technique, the injection of autologous fat harvested from the abdomen by liposuction has been abandoned as complication rates are unacceptably high. In particular, deformities such as penile curvature or asymmetry of the penis as well as the formation of nodules of liquefied, necrotic or calcified adipose tissue (sclerosing lipogranuloma) are not uncommon due to reabsorption or migration.

Silicone injection

This procedure involves the injection of liquid injectable silicone (LIS) into the dartos fascia, and is not recommended because of the high rate of complications. In particular, penile swelling, penile distortion, formation of granulomas, migration of the LIS and idiosyncratic reactions are common. Moreover, injection of LIS into the dartos fascia increases the risk of damaging the nerves and blood vessels present within the neurovascular bundle leading to loss of sensation and ultimately sexual dysfunction.

Hyaluronic acid injection

Better known for its role in facial soft tissue augmentation, hyaluronic acid gel injection has been used as a tissue filler for glans penis augmentation.

Graft procedures

Dermal fat grafts and flaps

A dermal fat graft consisting of all the layers of the skin and the subcutaneous tissue after the removal of the epidermis can be used for penile girth augmentation as an alternative to fat injection. Dermal fat grafts are usually harvested from the abdomen and gluteal folds and are placed circumferentially in the plane between the dartos and Buck's fascia.

Although complications such as donor site scarring and deformity can occur, and persistent postoperative penile edema and induration, venous congestion and fibrosis leading to persistent penile deformity are not uncommon. The success rate of this technique is far superior to that of fat injection. Necrosis of the fat component of the graft, which is progressively replaced by fibrotic tissue, inevitably occurs 8 weeks postoperatively and leads to contracture, deformity and loss of penile circumference.

As an alternative to free dermal fat grafts, skin flaps can be used for penile girth enhancement. Favorable results in terms of girth increase and cosmetic result have been achieved with the use of dermal fat groin flaps in patients who have previously undergone malleable penile prosthesis implantation. Although the procedure appears easily reproducible and safe, it bears the risk of flap ischemia and contracture resulting in penile curvature and shortening of the penis, especially if carried out in patients who have not previously undergone a penile prosthesis implantation.

Allografts, xenografts and scaffolds

Allografts, xenografts and scaffolds can be used for penile girth augmentation as an alternative to injectable materials, dermal fat grafts and flaps. The advantage of using allografts and xenografts is a shorter operative time, as no graft or flap needs to be harvested with the additional advantage of no donor site morbidity, a good graft take and low complication rates. Alloderm® is the most common allograft used in penile girth enhancement and is an acellular inert dermal matrix derived from donated human skin tissue. Porcine small intestinal submucosa (SIS®) and bovine pericardium (Peri-Guard®) are alternative xenografts commonly used in penile surgery.

Although rare, erosion, resorption, fibrosis, contracture and skin loss are the most common complications associated with penile girth augmentation using allografts.

An alternative approach has used biodegradable scaffolds as grafts for penile girth augmentation. This involves an autologous *ex vivo* tissue engineering process whereby fibroblasts previously harvested from the patient's scrotal dermal tissue are seeded on to a pretreated tube-shaped biodegradable scaffold (Figure 8.28). The fibroblast-

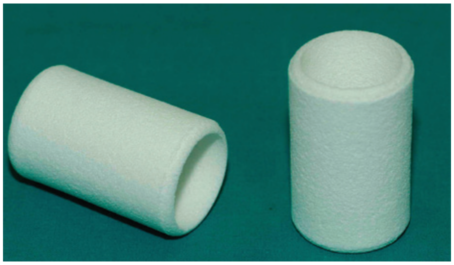

Figure 8.28 Fibroblasts are harvested from the patient's scrotum and seeded on to the scaffold.

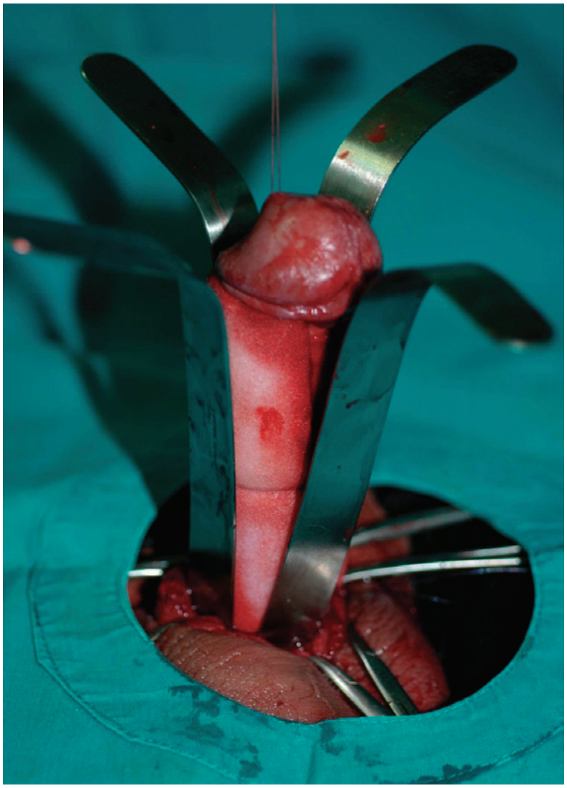

Figure 8.29 The scaffold is applied to the penile shaft in the plane between Buck's fascia and the dartos layer.

seeded scaffolds are then incubated for 24 hours before their implantation around the penile shaft, in the plane between Buck's fascia and the dartos (Figure 8.29). Postoperatively, the scaffold undergoes a progressive remodeling characterized by initial diffuse infiltration by inflammatory cells and substitution with a collagen-rich hypervascularized tissue that resembles the normal dartos layer. In a series of 84 patients with penile dysmorphophobia who had previously failed penile girth enhancement surgery and who have undergone penile girth augmentation with the use of biodegradable scaffolds, Perovic *et al*. reported an average postoperative girth increase of 3.1 cm with high satisfaction rates (Figures 8.29, 8.30 and 8.31).

Venous grafts

In 2002, Austoni *et al.* described a new technique of girth augmentation that, contrary to all of the above described procedures, involved increasing the circumference of the corpora cavernosa by using bilateral venous graft implantation. This is the only procedure that guarantees an increased girth during erection.

Bilateral longitudinal incisions are performed in the tunica albuginea from the level of the coronal sulcus to

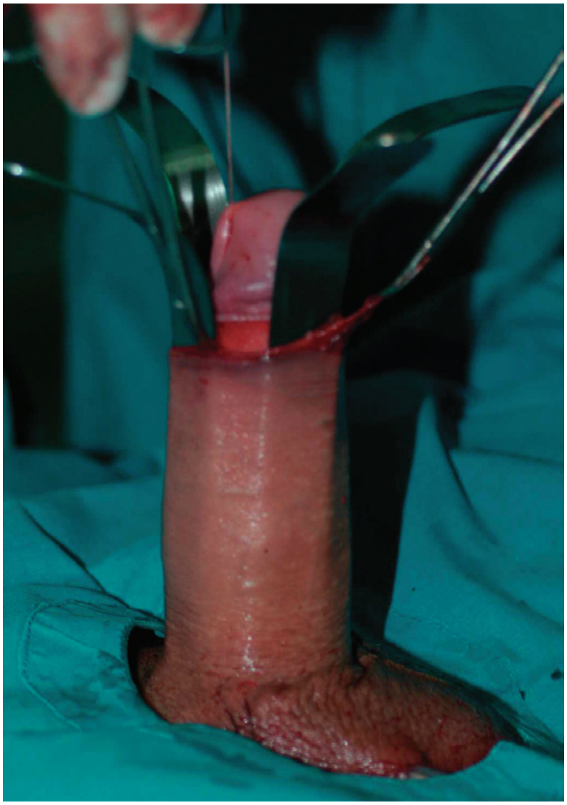

Figure 8.30 The scaffold is then covered with the skin and dartos layer.

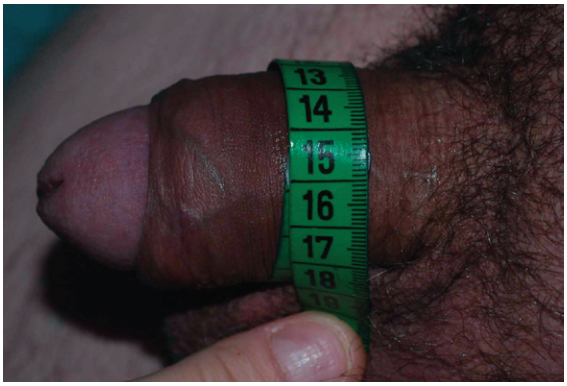

Figure 8.31 Postoperative result at 1 year showing the increase in the girth. (Source: Perovic SV, Sansalone S, Djinovic R *et al.* 2010. Reproduced with permission of John Wiley & Sons Ltd.)

the proximal aspect of the penile shaft on each side of the urethra and the resultant defect is grafted using a saphenous vein patch in order to widen the corpora cavernosa.

In Austoni's series, a postoperative girth increase of up to 2.1 cm was reported, with all patients engaging in penetrative sexual intercourse and satisfied with the cosmetic and functional outcome of surgery.

Further reading

Alter GJ. Augmentation phalloplasty. Urol Clin North Am 1995; 22:887–902.

Alter GJ. Penile enlargement surgery. Tech Urol 1998;4:70–6.

Alter GJ, Jordan GH. Penile elongation and girth enhancement. AUA Update Series 2007;26:229–37.

Austoni E, Guarneri A, Cazzaniga A. A new technique for augmentation phalloplasty: albugineal surgery with bilateral saphenous grafts – three years of experience. Eur Urol 2002; 42:245–53.

Bruno JJ 2nd, Senderoff DM, Fracchia JA, Armenakas NA. Reconstruction of penile wounds following complications of AlloDerm-based augmentation phalloplasty. Plast Reconstr Surg 2007;119:1–4e.

Chung E, Clendinning E, Lessard L, Brock G. Five-year follow-up of Peyronie's graft surgery: outcomes and patient satisfaction. J Sex Med 2011;8(2):594–600.

Garaffa G, Christopher AN, Ralph DJ. The management of genital lymphoedema. BJU Int 2008:102(4):408–14.

Kim JJ, Kwak TI, Jeon BG, Cheon J, Moon DG. Human glans penis augmentation using injectable hyaluronic acid gel. Int J Impot Res 2003;15:439–43.

Klein R. Penile augmentation surgery. Electronic Journal of Human Sexuality; 1999. Available at: http://www.ejhs.org/volume2/klein/penis10.htm (accessed 4 February 2013).

Li C-Y, Kayes O, Kell PD, Christopher AN, Minhas S, Ralph DJ. Penile suspensory ligament division for penile augmentation: indications and results. Eur Urol 2006;49:729–33.

Long DC. Elongation of the penis. Zhongua Zheng Xing ShaoShang Wai Ke Za Zhi 1990;6:17–9.

Moon DG, Yoo JW, Bae JH, Han CS, Kim YM, Kim JJ. Sexual function and psychological characteristics of penile paraffinoma. Asian J Androl 2003;5:191–4.

Narins RS, Beer K. Liquid injectable silicone: a review of its history, immunology, technical considerations, complications and potential. Plast Reconstr Surg 2006;118(Suppl):77S–84S.

Panfilov DE. Augmentative phalloplasty. Aesth Plast Surg 2006; 30:183–97.

Perovic SV, Byunb J, Scheplevic P, Djordjevica M, Kimd J, Bubanja T. New perspectives of penile enhancement surgery: tissue engineering with biodegradable scaffolds. Eur Urol 2006;49:139–47.

Perovic SV, Sansalone S, Djinovic R, Ferlosio A, Vespasiani G, Orlandi A. Penile enhancement using autologous tissue engineering with biodegradable scaffold: a clinical and hystomorphometric study. J Sex Med 2010;7(9):3206–15.

Roos H, Lissoos I. Penis lengthening. Int J Aesth Restor Surg 1994;2:89–96.

Sawhney CP, Banerjee TN, Chakravarti RN. Behaviour of dermal dermal fat transplant. Br J Plast Surg 1969;22:169–76.

Shaeer O. Supersizing the penis following penile prosthesis implantation. J Sex Med 2010;7(7):2608–16.

Spyropoulos E, Christoforidis C, Borousas D, Mavrikos S, Bourounis M, Athanasiadis S. Augmentation phalloplasty surgery for penile dysmorphophobia in young adults: considerations regarding patient selection, outcome evaluation and techniques applied. Eur Urol 2005;48:121–8.

Vardi Y, Harshai Y, Gil T, Gruenwald I. A critical analysis of penile enhancement procedures for patients with normal penile size: surgical techniques, success and complications. Eur Urol 2008;54:1042–50.

Wassermann RJ, Greenwald DP. Debilitating silicone granuloma of the penis and scrotum. Ann Plast Surg 1995;35:505–10.

Whitehead ED. Allografts dermal matrix graft (Alloderm®) for pericavernosal penile widening in normal men. Abstract presented at: First World Congress of Aesthetic Medicine; March 15–17, 2004; Rio de Janeiro, Brasil.

Wollin M, Duff PG, Malone PS, Ransley PG. Buried penis: a novel approach. Br J Urol 1990;65:97–100.

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Surgery for Male Infertility

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Introduction

In approximately 25% of infertile couples, a male factor is found to be the underlying cause for infertility. In a further 25% of couples a combination of both male and female factors is identified. Therefore male factors are identified in 50% of couples seeking infertility treatment.

Although the use of *in vitro* fertilization (IVF) resulted in a live birth in 1978, this medical landmark allowed previously infertile women to conceive and undergo a natural pregnancy. However, it was only until the advent and widespread availability of intracytoplasmic sperm injection (ICSI) in 1992 that infertility treatment for men who were previously deemed infertile has been revolutionized. Surgery for male factor infertility broadly involves either reconstructive techniques for obstructive azoospermia (OA) or sperm retrieval techniques for non-obstructive azoospermia (NOA).

Clinical features

Obstructive azoospermia

OA can occur at any site along the male reproductive tract. This can be intratesticular at the level of the efferent ductules right up to the level of the ejaculatory ducts. Approximately 6% of infertile men have an obstructive etiology for their infertility. Intratesticular obstruction at the level of the efferent ductules is rare and not amenable to microsurgical reconstruction. These patients will require sperm retrieval followed by ICSI treatment. The most common site of obstruction is at the level of the vas deferens either following a vasectomy for sterilization or due to an iatrogenic injury secondary to inguinal surgery (e.g. herniorrhaphy or orchidopexy) or trauma.

Approximately 5% of men undergo a vasectomy but changes in social circumstances or relationships often results in a significant proportion of these men requesting a vasectomy reversal in order to achieve paternity. On clinical examination the testicles are of normal volume and consistency with distension of the proximal epididymis. The gap between the cut ends of the vas are normally obvious to palpation.

Ejaculatory duct obstruction (EDO) is due to stenosis of the ejaculatory ducts or obstruction secondary to congenital cysts, most commonly Mullerian duct cysts. The most common causes for EDO are listed in Table 9.1. Men with OA secondary to EDO may also develop additional symptoms such as pre and post ejaculatory pain in the testicles or perineum as well as a low volume ejaculate. In a further 20% hemospermia is reported. Chronic pain is alleviated in 60% of the patients once the obstruction has resolved.

In azoospermic or severely oligozoospermic patients, a clinical examination which detects normal-sized testicles with epididymal engorgement combined with a normal serum follicle stimulating hormone (FSH) requires further investigation to exclude OA.

Nonobstructive azoospermia

NOA is caused by impaired spermatogenesis within the testicles. Clinically, the testicles are soft in consistency with a reduced testicular volume. The testicular volume is variable according to the underlying cause for NOA (Table 9.2). As a general rule, infertile men found to have testicles that have a longitudinal length of less than 4 cm in combination with an elevated serum FSH are likely to be diagnosed with NOA.

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Table 9.1 Common causes of ejaculatory duct obstruction (EDO)

Congenital	Acquired
Mullerian duct cyst	Post surgical fibrosis
Wolffian duct cyst	Post inflammatory fibrosis
Congenital atresia of ducts	Calculi

Table 9.2 Common causes of nonobstructive azoospermia (NOA)

- Previous cryptorchidism
- Testicular torsion
- Infections (mumps orchitis, TB, systemic viral)
- Gonadotoxins (chemotherapy, radiotherapy)
- Genetic (Klinefelter's, androgen insensitivity)

Assessment

A combination of radiologic investigations and serum levels of FSH, luteinizing hormone (LH) and testosterone will provide further information as to whether the underlying factor is NOA or OA. In NOA the FSH levels are elevated and there may also be a concomitant reduction in the serum total and free testosterone. In OA the serum levels of FSH, LH and testosterone are generally within the normal range.

Two semen analyses are required to confirm the presence of azoospermia according to the 2010 World Health Organization (WHO) criteria (Table 9.3). A semen analysis confirms the absence of sperm and also measures the ejaculatory volume. Typically, a semen analysis that shows a low volume ejaculate with an acid pH and an absence of fructose would be in keeping with EDO (secondary to a congenital Mullerian duct cyst or stenosis of the ejaculatory ducts) or seminal vesicle atresia which occurs in congenital bilateral absence of vas deferens (CBAVD).

Transrectal ultrasound using a probe with a 7-MHz frequency or greater is a reliable technique to measure the degree of seminal vesicle dilatation and the diameter of the ejaculatory ducts. The normal width of the seminal vesicle is up to 1.5 cm and the ejaculatory duct is up to 2.3 mm. In cases where there is diagnostic uncertainty a seminal vesiculogram can be performed by injecting contrast directly into the seminal vesicle using a transrectal ultrasound probe. By screening in real time the degree of seminal vesicle distension and flow through the ejaculatory duct can be visualized. In cases of partial EDO oligoesthenospermia is a feature. However, the diagnosis may require further seminal vesiculography for confirmation. Alternatively, a T2 weighted magnetic resonance imaging (MRI) scan can detect midline lesions causing obstruction. Other nonsurgical factors that can result in ejaculatory duct or distal seminal vesicle duct impairment are listed in Table 9.4.

Table 9.3 World Health Organization (WHO) ranges for semen analysis

Parameter	Lower reference limit
Semen volume (mL)	1.5 (1.4–1.7)
Total sperm number (10^6 per ejaculate)	39 (33–46)
Sperm concentration (10^6 per mL)	15 (12–16)
Total motility (PR + NP, %)	40 (38–42)
Progressive motility (PR, %)	32 (31–34)
Vitality (live spermatozoa, %)	58 (55–63)
Sperm morphology (normal forms, %)	4 (3.0–4.0)
Other consensus threshold values	
pH	≥7.2
Peroxidase-positive leukocytes (10^6 per mL)	<1.0
MAR test (motile spermatozoa with bound particles, %)	<50
Immunobead test (motile spermatozoa with bound beads, %)	<50
Seminal zinc (µmol/ejaculate)	≥2.4
Seminal fructose (µmol/ejaculate)	≥13
Seminal neutral glucosidase (mU/ejaculate)	≥20

MAR, mixed antiglobulin reaction; NP, nonprogressive; PR, progressive. (Source: Adapted from World Health Organization 2010 *WHO Laboratory Manual for the Examination and Processing of Human Semen*, Fifth edition. WHO, Geneva.)

Table 9.4 List of pharmacotherapies associated with functional ejaculatory duct obstruction (EDO)

- Antihypertensives – adrenergic blockers, thiazides
- Antipsychotic agents – thioridazine, haloperidol
- Antidepressants – imipramine, amitriptyline
- Diabetes
- Polycystic kidney disease

CBAVD occurs in men with mutations of the cystic fibrosis transmembrane regulator (*CFTR*) gene which is located on the short arm of chromosome 7. Clinical examination may occasionally be difficult because of the patient's size or because of the presence of a bulky rugose scrotum. In these situations an ultrasound scan of the scrotum is useful to confirm the diagnosis of absent vas deferens and a transrectal ultrasound will visualize the seminal vesicles which often show atresia.

Other variations include unilateral absence of the vas deferens combined with renal anomalies. However, bilateral absence of vas deferens associated with renal anomalies is not caused by a *CFTR* mutation.

In cases of NOA or where there is diagnostic uncertainty as to whether the underlying cause for the azoospermia is due to NOA or OA, a genetic profile including a karyotype and Y deletion (typically looking for *AZFa, AZFb* and *AZFc* gene deletions) should be carried out. The presence of *AZF* deletions is useful to predict the outcome of a surgical sperm retrieval and a karyotype will detect Klinefelter's as well as 47XYY and 46XX male syndrome. If an *AZFa* or *AZFb* deletion is found then the chances of a successful sperm retrieval are virtually zero.

The role of varicocele surgery in men presenting with infertility remains controversial. Although varicoceles are present in 11% of the male population, 25% of men presenting with infertility present with a varicocele. Treating a palpable varicocele (Grade II or III) is likely to improve the semen parameters in men with low sperm counts, poor motility or abnormal morphology.

Surgical management

Obstructive azoospermia

Obstructive azoospermia secondary to a vasectomy for sterilization is amenable to surgical reconstruction by performing a vasovasostomy (vasectomy reversal). The patency rates and pregnancy rates will be governed by the time interval between having the vasectomy and the reversal. This is an important consideration in patients where there has been a long interval between the vasectomy and the vasovasostomy as the outcomes following IVF treatment can be equivalent to a vasectomy reversal if there has been a 10-year interval between the two procedures. Another consideration is the number of pregnancies planned and whether there are ethical or religious considerations which mean that some couples have no option but to try and conceive naturally.

Men diagnosed with CBAVD are not amenable to surgical reconstruction although almost all of these patients will have normal spermatogenesis within the testicles. Therefore a surgical sperm retrieval is likely to yield enough sperm for treatment by ICSI. It is important to ensure that these patients have undergone genetic counseling prior to undergoing treatment.

Iatrogenic injuries to the vas secondary to inguinal hernia repairs or trauma present a challenge for reconstruction. Iatrogenic injuries to the vas following a pediatric hernia repair (where no synthetic mesh is used) are easier to deal with by performing a vasovasostomy than those where a mesh hernia repair has been performed. Exploration of the inguinal canal following a mesh hernia repair typically finds the vas deferens encased in fibrotic scar tissue.

EDO can be surgically treated by either deroofing a Mullerian duct cyst which may either be compressing the ducts or the ejaculatory ducts may be opening directly into the cyst. The EDO may be partial or complete and a transurethral resection of ejaculatory ducts (TURED) can be performed under transrectal ultrasound guidance to relieve the obstruction. This allows direct visualization of the ducts during resection and also allows confirmation of patency by performing a seminal vesiculogram at the end of the procedure. Rarely, a hemi-TURED is performed for unilateral obstruction.

Nonobstructive azoospermia

Successful sperm retrieval in cases of NOA depends on the underlying etiology of the impaired spermatogenesis. The presence of focal areas of spermatogenesis within the testicle allows a surgical sperm retrieval to be performed prior to ICSI. Techniques for surgical sperm retrievals vary although microsurgical testicular exploration and sperm extraction (mTESE) has been found to have a better success rate in NOA.

Surgical techniques

Obstructive azoospermia

Vasovasostomy

Depending on the technique utilized for the original vasectomy procedure, the defect in the vas is normally palpable. However, the site of the vasectomy is never entirely clear until the two ends of the vas are delivered through the wound. A vasectomy performed on the straight part of the vas allows a relatively easy anastomosis to be performed. However, if the vas has been transected at the convoluted part then there is a mismatch in the caliber of the lumen. Distal patency is confirmed by either using an 0 nylon suture passed through the abdominal end of the vas or by gently flushing the vas. At the testicular end the viscosity of the vasal fluid and microscopic examination of the fluid to confirm the presence of sperm dictates as to whether a vasovasostomy should be performed or whether one should proceed to an epididymovasostomy (Figures 9.1, 9.2, 9.3, 9.4 and 9.5).

The procedure is normally performed as a daycase procedure. Either a horizontal infrapubic approach or a scrotal incision (midline raphe or lateral scrotal incisions) can be used depending on the surgeon's preference. Whichever approach is used, extension of the incision to the superficial ring in order to mobilize the abdominal end of the vas is often required.

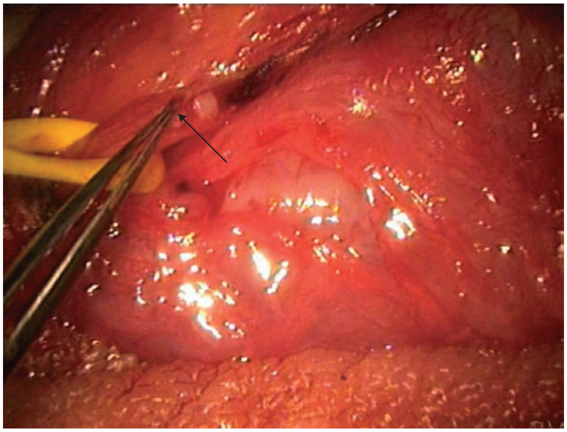

Figure 9.1 The ends of the abdominal and testicular vas are isolated. Careful dissection of the adventitia is performed (arrow) ensuring that the vas is not devascularized which can result in delayed stenosis. Two techniques are commonly used with no difference in ejaculated sperm outcome. The modified single layer method requires 4–6 full thickness sutures (nylon 9-0) through the muscularis and mucosa with some adventitial sutures to ensure "water-tightness." The alternative is the two-layer method with 4-6 mucosal only sutures (nylon 10-0) followed by 9-0 nylon adventitial sutures. The picture sequence demonstrates the modified single-layer method.

Postoperative care

Patients are advised to avoid ejaculation for up to 3–4 weeks and then perform a semen specimen at 8 weeks. The presence of sperm in the ejaculate confirms patency.

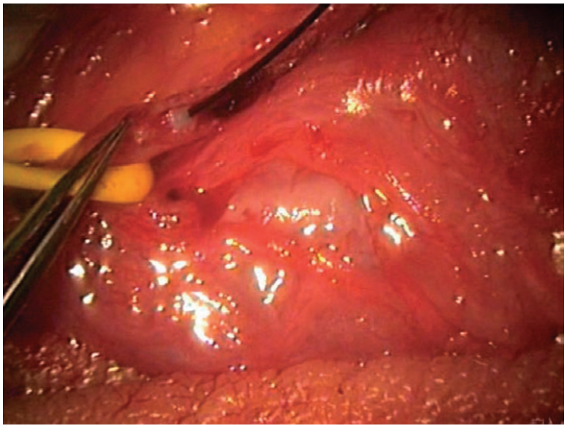

Figure 9.2 A nylon suture used as a stent is gently introduced into the abdominal end of the vas to check for patency.

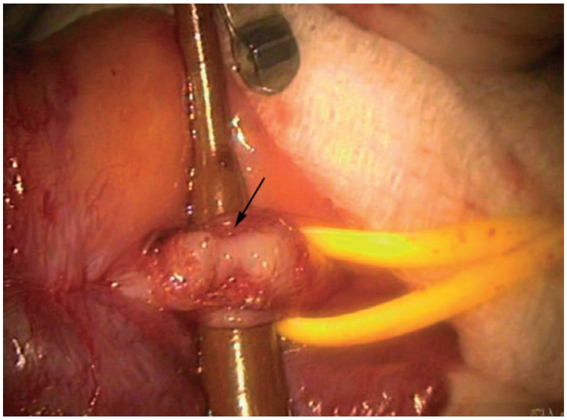

Figure 9.3 Copious fluid from the testicular end of the vas is a good indicator for the presence of sperm and hence good surgical outcome.

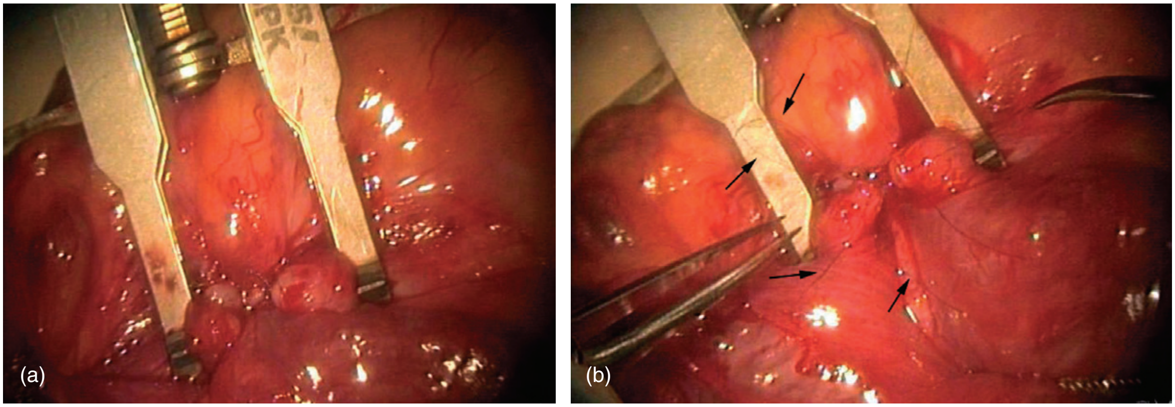

Figure 9.4 (a) A vasectomy reversal clamp is used to approximate the two ends of the vas. (b) Four full thickness 9-0 sutures have been inserted. The arrows show the position of the sutures. These are tied and the vas clamp is rotated so that the opposite side can be sutured using the same technique.

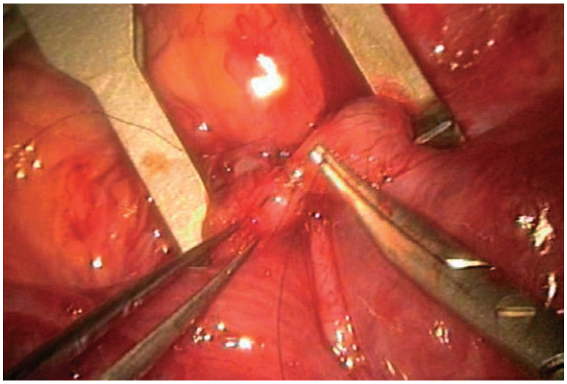

Figure 9.5 Interrupted adventitial sutures are used to ensure that there is no leak from the anastomosis site.

Epididymovasostomy

In cases where there is no vasal fluid obtained from the testicular end or the vasal fluid is viscous, a standard vasovasostomy has to be converted to an epididymovasostomy. Unless there has been an "epididymal blow out" resulting in extensive fibrosis, the epididymal tubules are sufficiently dilated to allow a microsurgical anastomosis between the vas and the epididymal tubule. Once an appropriate tubule has been found, confirmation of sperm from the aspirate is required before completing the anastomosis.

Two surgical techniques are described.

Intussusception technique

This technique is quicker and easier than the conventional technique with similar outcomes (Figures 9.6, 9.7, 9.8, 9.9, 9.10, 9.11, 9.12, 9.13 and 9.14).

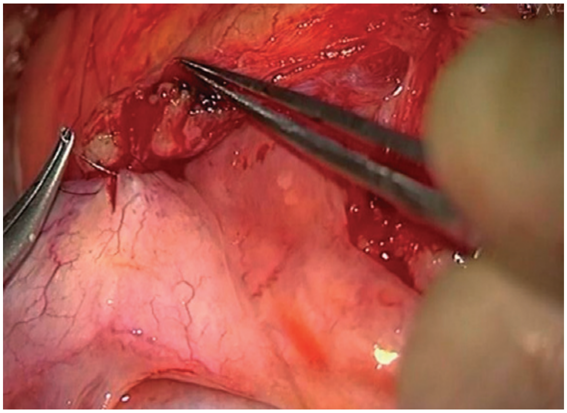

Figure 9.6 The tail and body of the epididymis is examined initially. The more distal the tubule on the epididymis, the greater is the probability of locating motile sperm. The epididymal tunica is incised and a dilated epididymal tubule is identified.

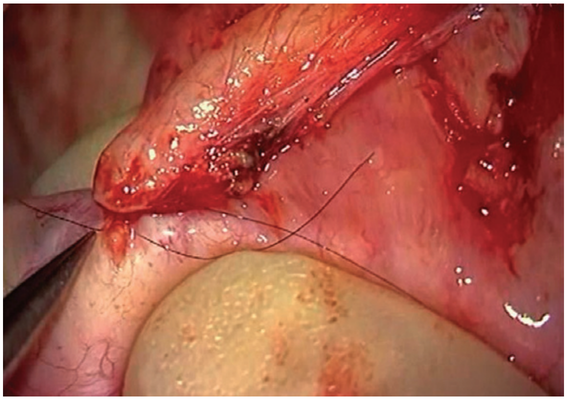

Figure 9.7 The adventitia of the vas on the posterior wall is sutured to the tunica of the epididymis using interrupted 9-0 nylon in order to secure the vas into position. The lateral two of the three back wall sutures are left untied till later to allow easy access to the epididymal tubule and vas lumen.

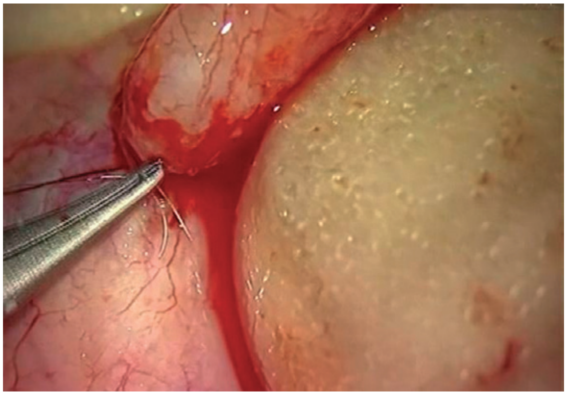

Figure 9.8 The needles of two double-ended 10-0 nylon sutures are inserted into the epididymal tubule but not pulled through the tubule.

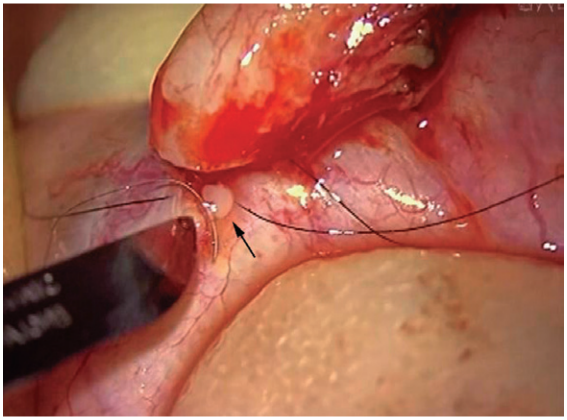

Figure 9.9 The epididymal tubule is incised and fluid is aspirated from the tubule using an angiocatheter in order to confirm the presence of sperm (arrow). Confirmation of sperm using a light microscope is required before proceeding further. Methylene blue can be used in order to define the opened edges of the tubule as everything is stained blue except for the luminal mucosa.

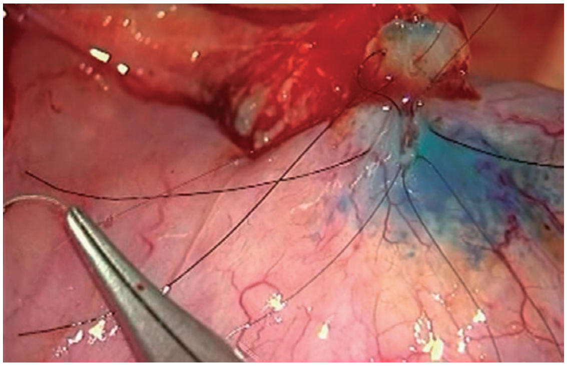

Figure 9.10 Once sperm are confirmed, both epididymal needles (proximal needles) are pulled through. The distal needles are then passed from mucosa into muscularis at the posterior wall on either side (nearest to the epididymis).

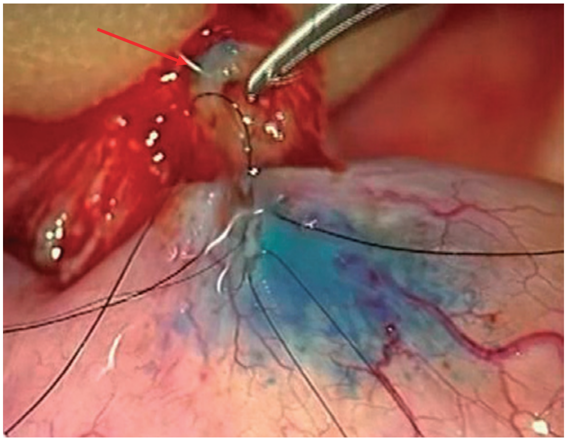

Figure 9.11 The proximal needles are passed in a similar fashion at the anterior wall, i.e. furthest away from epididymis (red arrow).

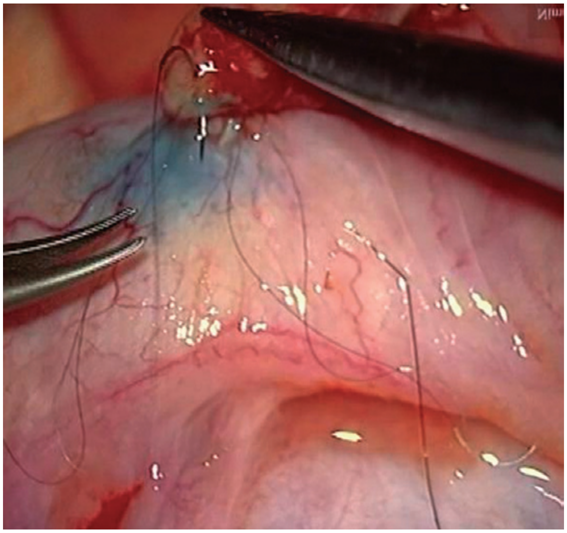

Figure 9.12 A further three 9-0 nylon sutures are used to suture the adventitia of the vas to the epididymal tunica on the anterior wall.

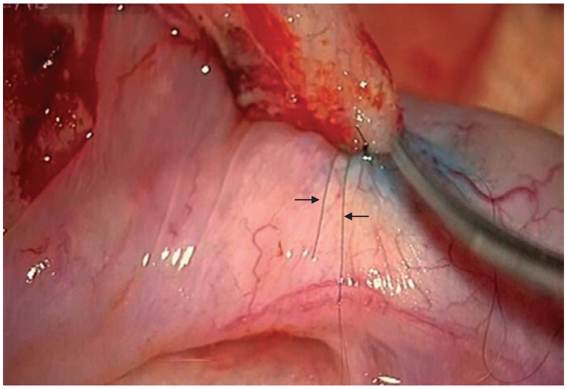

Figure 9.13 The 10-0 sutures (arrow) are then tightened which draws up the epididymal tubule into the vas lumen. This step can also precede the placement of the anterior sutures depending on the surgeon's preference.

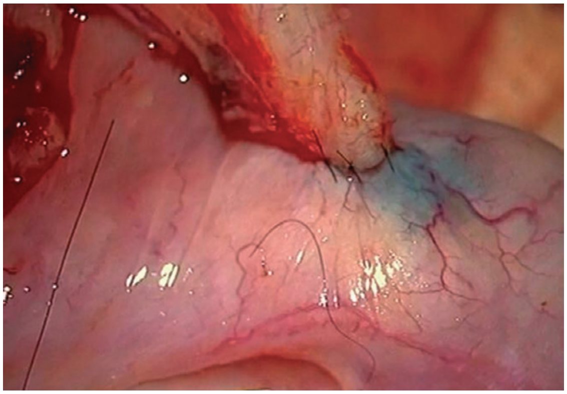

Figure 9.14 Final appearance of the anastomosis.

Conventional technique

The conventional technique uses an end to side anastomosis between the vas and the epididymal tubule. The tubule which is isolated should be opened and the fluid checked for motile sperm. If sperm are not present then a tubule further upstream should be used. (See Figures 9.15, 9.16 and 9.17.)

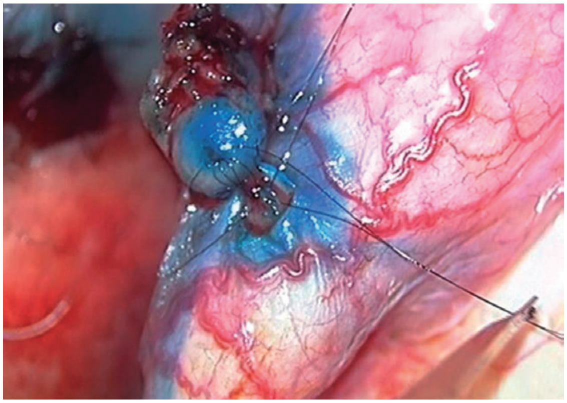

Figure 9.15 A conventional vasoepididymostomy utilizes interrupted 10-0 nylon sutures between the incised tubule and the vas mucosa. Between 5 and 6 sutures are used for the mucosal anastomosis. This is technically more difficult than the intussusception technique as the epididymal tubule is now collapsed. The adventitia is sutured as described above using 9-0 nylon.

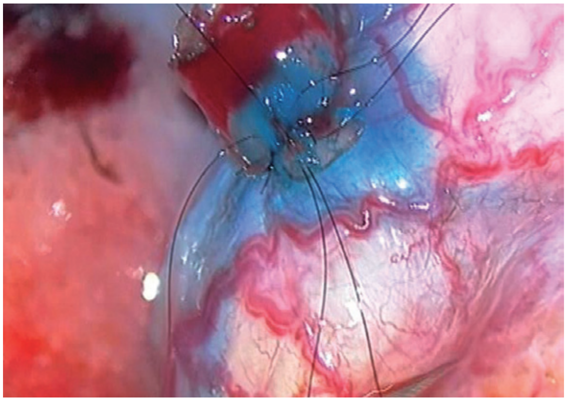

Figure 9.16 The anterior sutures have been placed after tying the posterior sutures.

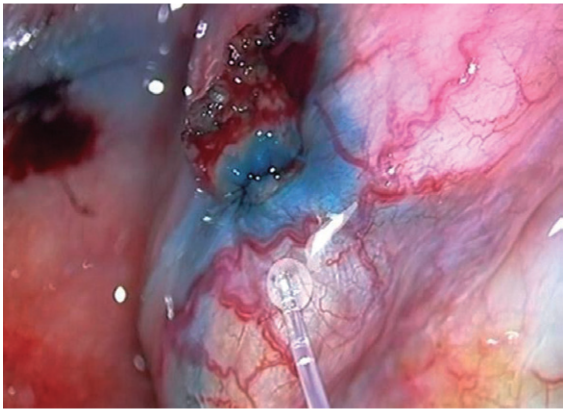

Figure 9.17 The anterior sutures have been tied. The operation is completed by suturing the adventitia of the vas to the tunica of the epididymis.

Postoperative care

A scrotal support should be worn for 5 days in order to reduce the degree of swelling and ensure that the anastomosis is not disrupted. Ice packs can be used for the first 24 hours to reduce the scrotal swelling. Patients are advised to avoid ejaculation for 3–4 weeks and warned that it can often take 3–18 months for sperm to appear in the ejaculate.

Transurethral resection of ejaculatory ducts

Confirmation of EDO using a transrectal ultrasound of the prostate and seminal vesicles should be performed preoperatively. Dilatation of the ejaculatory ducts and seminal vesicles is seen in EDO. For borderline cases or partial EDO, a seminal vesiculogram can be performed either preoperatively for diagnosis or intraoperatively to assist in directing the site and depth of the resection (Figures 9.18, 9.19, 9.20, 9.21, 9.22, 9.23, 9.24 and 9.25).

Risks

The risks of TURED are listed below. Because the procedure is undertaken in young men with little prostatic adenoma, the distance between the bladder neck and external sphincter is short. Therefore careful visualization of the landmarks is required to avoid inadvertent injury to these structures. Specific risks are:

1 Bleeding;
2 Postoperative urinary tract infection;
3 Recurrent epididymitis;
4 Watery ejaculation;
5 Retrograde ejaculation if inadvertent resection of the bladder neck is performed;
6 Urinary incontinence due to external sphincter injury; and
7 Restenosis of the ejaculatory ducts

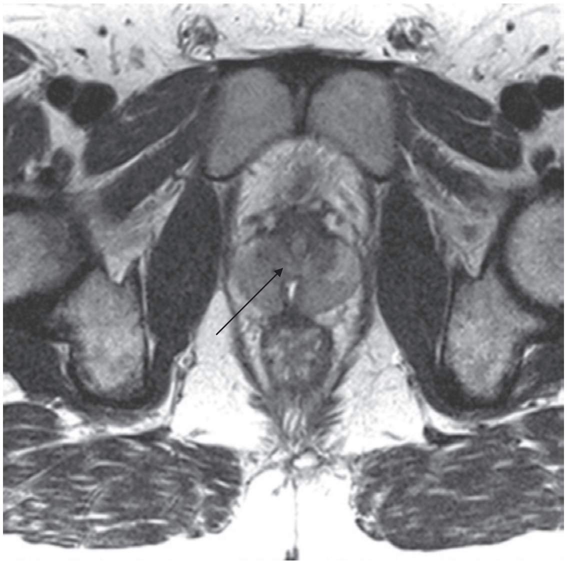

Figure 9.18 Preoperative T2 weighted magnetic resonance imaging (MRI) scan demonstrating a midline Mullerian duct cyst (arrow).

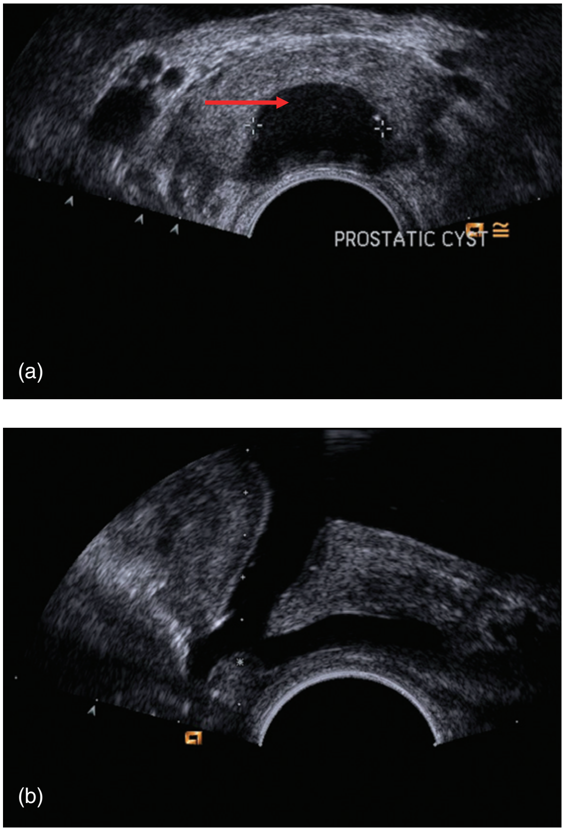

Figure 9.19 Transrectal ultrasound demonstrating a midline Mullerian duct cyst and dilated ejaculatory ducts entering the cyst. (a) Transverse view; (b) sagittal view.

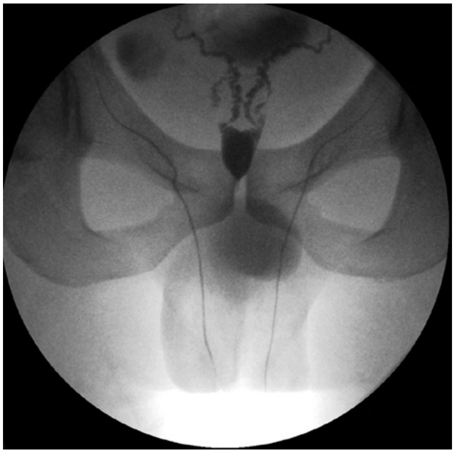

Figure 9.20 A seminal vesiculogram demonstrating a midline Mullerian duct cyst. The seminal vesicles are punctured with a 21-gauge Chiba needle. Light microscopy of aspirated seminal vesicle fluid will detect nonmotile sperm which is diagnostic of obstruction. The seminal vesicle is injected with a mixture of diluted methylene blue and nonionic contrast. Alternatively, the cyst can be injected directly with diluted methylene blue. Reflux of contrast is demonstrated into the vasa.

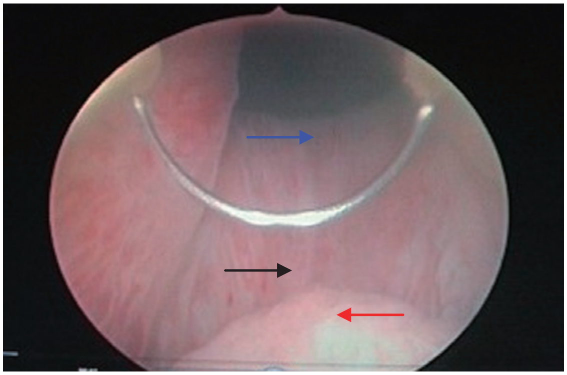

Figure 9.21 Antibiotics are administered to cover urinary and colonic bacteria. A 22-F or 24-F resectoscope is used to resect the prostatic tissue overlying the cyst. The bladder neck is viewed (blue arrow). The cyst is located at the level of the black arrow. The veru montanum is kept in view (red arrow). The transrectal ultrasound probe is used to guide the deroofing of the cyst.

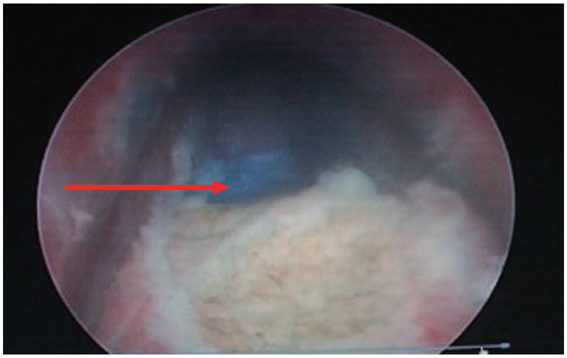

Figure 9.22 The roof of the cyst and part of the veru are resected using pure cutting current. Methylene blue is seen flowing out of the cyst. In patients with ejaculatory duct obstruction, a similar resection in the region of the veru montanum is performed to open the ejaculatory ducts. In rarer unilateral obstruction or Wolffian duct cysts a hemi-transurethral resection of ejaculatory ducts (hemi-TURED) is performed just lateral to the veru montanum.

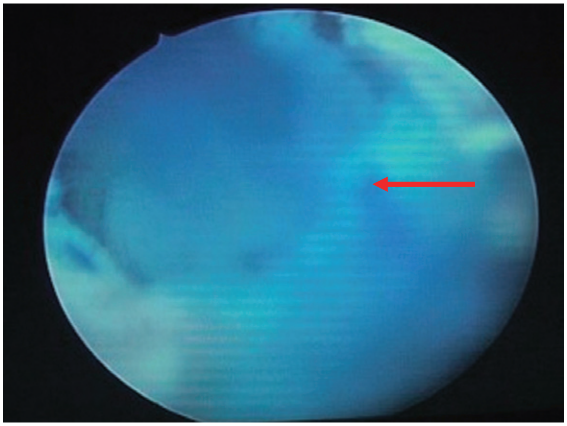

Figure 9.24 Methylene blue is seen flowing out of the left ejaculatory duct confirming patency.

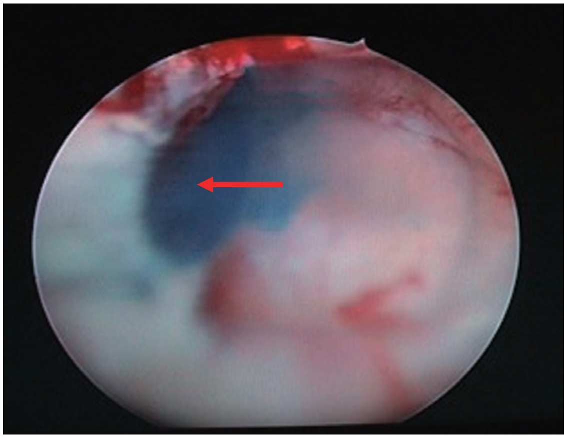

Figure 9.23 The cyst has been deroofed. Methylene blue is injected into the right seminal vesicle and is seen flowing out of the right ejaculatory duct (red arrow).

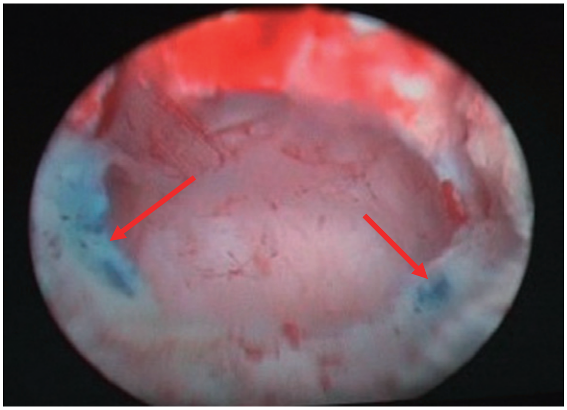

Figure 9.25 The ejaculatory ducts (red arrows) are shown to be patent following resection of the Mullerian duct cyst. An 18-F or 20-F catheter is inserted at the end of the procedure. Coagulating diathermy is avoided in the region of the ducts in order to avoid stenosis.

Percutaneous epididymal sperm aspiration (PESA)

This technique can be performed under local anesthetic and is suitable for patients undergoing ICSI due to obstructive azoospermia which is either not surgically reconstructable or who have already undergone an unsuccessful reconstruction. Patients with CBAVD or those who have undergone a previous vasectomy are also suitable for this procedure. The epididymal head in these cases is distended and easily palpable. If the epididymal head is not palpable then the surgeon should proceed to a sperm retrieval directly from the testicle by performing a testicular exploration and sperm aspiration (TESA) or TESE.

A local anesthetic spermatic cord block is optional as in most cases a single pass with a needle into the epididymis while aspirating is all that is required. However, a spermatic cord block offers postoperative pain control and also allows manipulation of the testicle and epididymis if further passes are necessary because of inadequate aspiration of epididymal fluid or insufficient motile sperm (Figure 9.26).

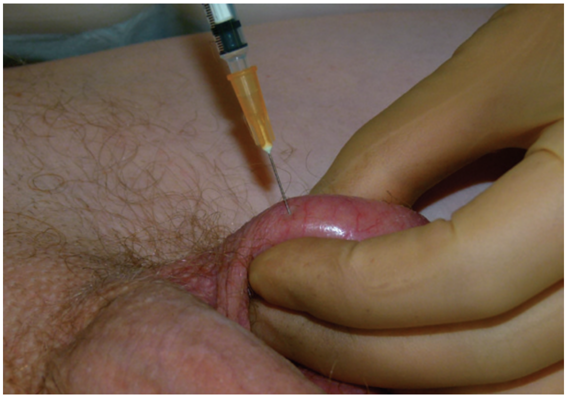

Figure 9.26 The patient is positioned supine and the surgeon stands on the left-hand side of the patient. The epididymis is palpated using the thumb and forefinger. The remaining fingers gently pull down on the body of the testicle providing traction. A 25-gauge needle or butterfly needle attached to a 2-mL syringe containing sperm buffer is inserted into the epididymal head aspirating as the needle is inserted.

Testicular exploration and sperm aspiration (TESA)

Patients with obstructive azoospermia in whom there is a high probability of retrieving sperm are suitable for a TESA. Although this technique is not usually performed as the primary sperm retrieval procedure, it is a useful back-up procedure if there has been a failed percutaneous epididymal sperm aspiration (PESA) or patients are unable to ejaculate on the day of the partner's egg collection.

TESA can be performed under a general or local anesthetic. The patient is positioned supine. A spermatic cord block is used for local anesthetic cases and this also provides analgesia following the procedure (Figure 9.27).

Microsurgical epididymal sperm aspiration (MESA)

Sperm aspirated directly from the epididymal tubules can be used for multiple IVF/ICSI cycles. Again this technique is predominantly utilized in patients with obstructive azoospermia. The procedure is performed under a general anesthetic or spinal anesthetic (Figure 9.28).

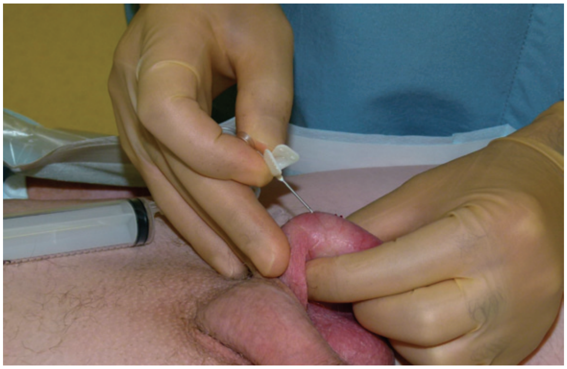

Figure 9.27 A 20-mL Luer lock syringe is attached to a 21-gauge butterfly needle. The body of the testicle is held and the needle is inserted directly into the body of the testicle aspirating in a number of directions while keeping the negative pressure on the syringe. This technique aspirates seminiferous tubules from the body of the testicle from which sperm can be retrieved.

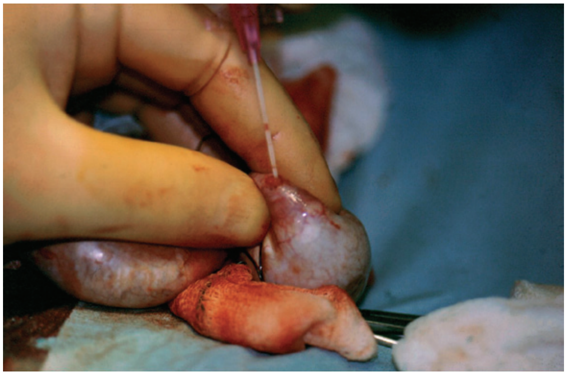

Figure 9.28 The testicle and epididymis are delivered through a midline raphe incision. A small incision is made in the tunica of the epididymis. An epididymal tubule is isolated and a small longitudinal incision is made in the tubule. Fluid is aspirated using an angiocatheter. The fluid is checked using a light microscope for the presence of motile sperm. If there is inadequate sperm present a further tubule is opened higher up on the body of the epididymis until adequate sperm has been retrieved. The epididymal tubule is sutured with 10-0 nylon sutures and the overlying tunica is sutured using 9-0 nylon sutures.

Nonobstructive azoospermia

Testicular exploration and sperm extraction (TESE)

TESE is performed in patients with NOA or in patients with OA where there has been a failure to retrieve sperm by PESA or MESA.

The operation is ideally performed under general anesthetic although local anesthetic can be used (Figure 9.29). Small transverse incisions are made in the tunica albuginea which avoid the subtunical blood vessels. Small biopsies are taken from each of these areas and analyzed for sperm. A further biopsy is placed in Bouin's solution for histologic analysis. This is particularly important in situations where there has been a failed sperm retrieval as it allows a histologic correlation.

Microdissection TESE

Microdissection TESE (micro-TESE) is increasingly being used as the primary procedure for a surgical sperm retrieval in NOA because of higher success rates in retrieving sperm from a lower volume of testicular tissue. The operation is performed under a general anesthetic and utilizes a high magnification operating microscope (×15–×24) in order to identify the dilated tubules within the testicle that have a higher probability of spermatogenesis. The procedure is performed under general anesthetic (Figures 9.30, 9.31, 9.32 and 9.33).

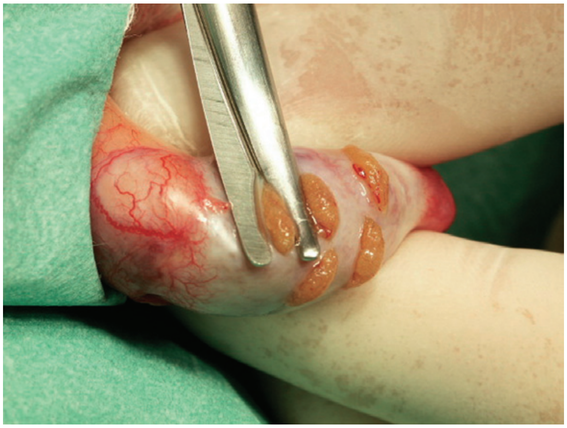

Figure 9.29 A midline incision in the scrotal raphe is performed. The tunica vaginalis is opened and the testicle is delivered. Small incisions are performed in the tunica albuginea using a No 15 scalpel parallel to the subtunical vessels. The seminiferous tubules are retrieved and placed into sperm medium. Further incisions are performed until sperm is retrieved. 4-0 Polyglactin sutures are used to close the tunical incisions. Figure courtesy of David Ralph.

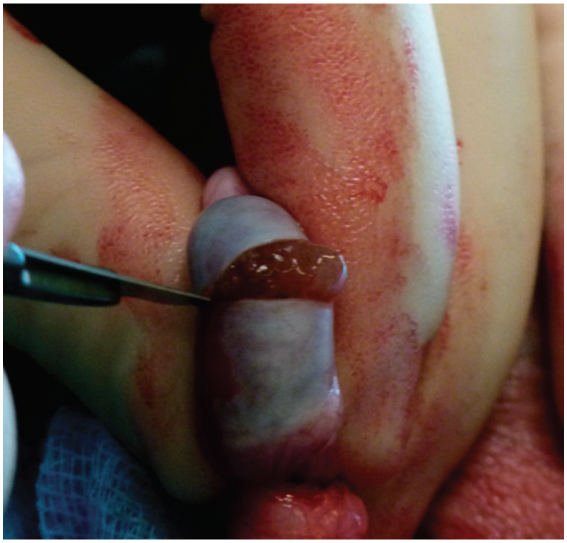

Figure 9.30 Following a midline scrotal incision and delivery of the testicle through the scrotal wound, an equatorial incision is performed in the tunica albuginea between the blood vessels.

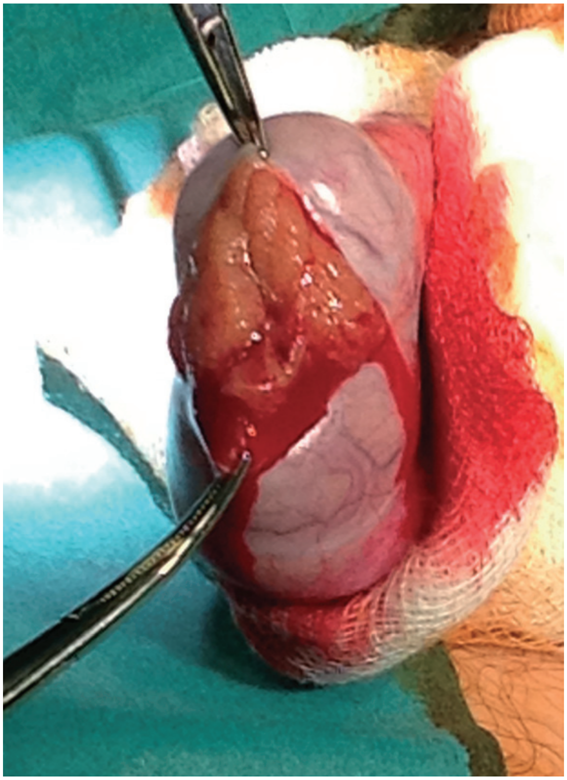

Figure 9.31 Two hemostats are applied to the tunica albuginea in order to open up the testicle.

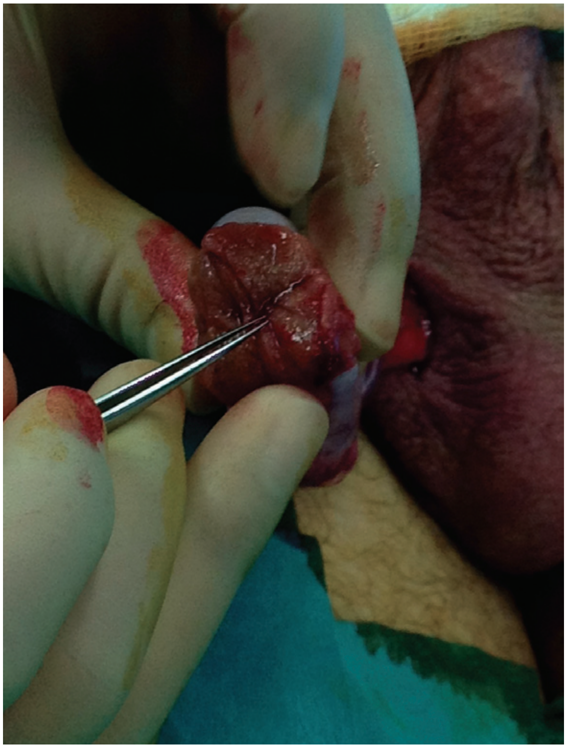

Figure 9.32 Careful dissection of the seminiferous tubules is performed between the blood vessels in an avascular plane. Individual tubules are dissected and retrieved with the most dilated and opaque tubules harvested. These are then further dissected and analyzed under a light microscope to confirm the presence of sperm. Once sperm have been confirmed the procedure ends. If sperm are not found then further dissection towards the rete testis is performed although care must be taken as to the level of dissection to avoid injury to the testicular blood vessels.

Surgical risks

Testicular sperm retrieval:

- Bleeding;
- Wound infection;
- Testicular atrophy; and
- Late hypogonadism.

PESA/MESA:

- Epididymitis; and
- Epididymal obstruction.

Vasovasostomy:

- Sperm granuloma; and
- Testicular artery injury.

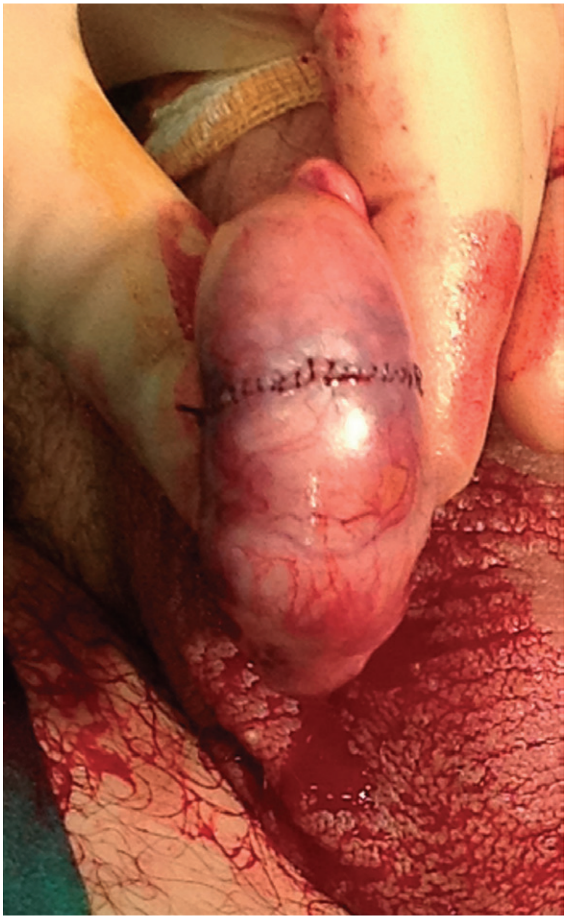

Figure 9.33 The tunica albuginea is closed using 4-0 polyglactin absorbable suture either as a continuous or an interrupted suture.

Microsurgical subinguinal varicocele ligation

A number of treatment options for varicoceles are available (Table 9.5). Of these procedures the lowest recurrence rate is following a microsurgical subinguinal approach (Figures 9.34 and 9.35).

Surgical risks

These include recurrent or persistent varicocele, hydrocele formation and testicular infarction.

Table 9.5 Common approaches to varicocele management
Radiologic retrograde embolization
Inguinal ligation (modified Ivanissevich)
High retroperitoneal ligation (modified Palomo)
Microsurgical subinguinal approach
Laparoscopic or robot-assisted ligation

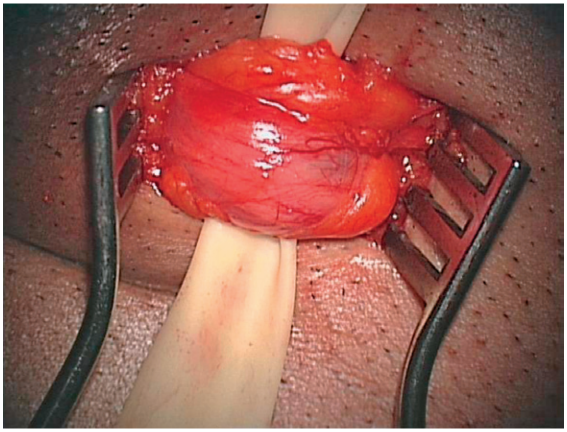

Figure 9.34 A subinguinal incision is used to expose the spermatic cord at the superficial inguinal ring. A Penrose drain is placed under the cord.

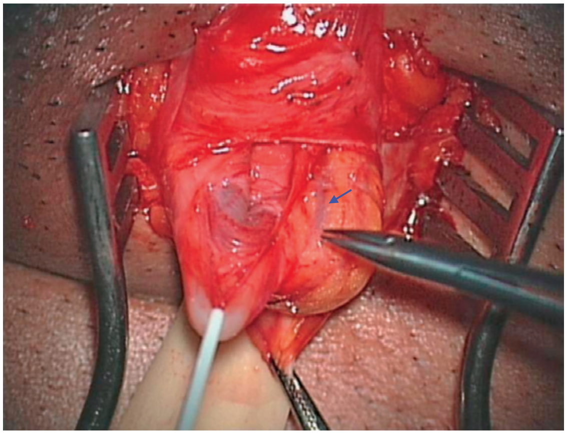

Figure 9.35 The procedure is performed microsurgically and involves identification and ligation of the testicular veins with preservation of the vas (white loop), artery, nerves and lymphatics. The veins (blue arrow) are ligated except the veins running with the vas deferens in order to prevent venous infarction.

Conclusion

Surgery for male factor infertility depends on the underlying cause. The increasing availability of ICSI has allowed men previously deemed infertile to father their own children. Reconstruction using either endoscopic or microsurgical techniques will potentially allow men with OA to fertilize naturally.

10

Urethral Reconstruction and Artificial Urinary Sphincters

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Urethral reconstruction

The urethra is divided into a posterior part located above the perineal membrane, and surrounded by the bladder neck, prostate and urethral sphincter mechanism; and an anterior part, located below the perineal membrane, surrounded by the corpus spongiosum (Figure 10.1). The posterior urethra is divided into the preprostatic urethra, the prostatic urethra and the membranous urethra. The anterior urethra is divided into the bulbar urethra, the penile or pendulous urethra and the fossa navicularis. This urologic terminology describing the urethra allows a clinical approach to the discussion of urethral pathology and surgery.

Urethral strictures are common, with an increasing incidence with age and reaching about 1 per 1000 men over the age of 65.

Clinical features

Historically, most strictures were associated with gonococcal urethritis before the advent of widespread antibiotics. Currently, idiopathic, traumatic and inflammatory strictures are more common in developed countries. Trauma includes post surgical trauma following endoscopic procedures or urethral catheterization as well as external trauma following penile fractures, straddle injuries of the bulbar urethra and pelvic fracture-related injuries of the proximal urethra. Lichen sclerosus can result in severe obliterative fibrosis of the fossa navicularis and difficult strictures of the remaining anterior urethra (Figure 10.2).

There are two principles of urethral reconstruction. First, the etiology and pathophysiology influences the choice of surgical treatment. External trauma causes ischemic necrosis leading to severe spongiofibrosis usually affecting the entire wall of the urethra (Figure 10.3). In some pelvic fracture urethral injuries, a complete urethral rupture with distraction of both ends effectively leaves a fibrotic gap once the hematoma resolves. On the other hand, an idiopathic bulbar stricture leads to only a relatively minor degree of spongiofibrosis and the bulk of the corpus spongiosum with its blood flow is intact.

The second factor influencing the choice of urethral stricture treatment is the length of the stricture. In an idiopathic stricture, the longer the affected urethral segment, the more likely it is that a significant proportion of the urethral wall is affected by spongiofibrosis and therefore unlikely to respond to endoscopic management (dilatation or optical urethrotomy).

However, in a symptomatic patient with a short sharp idiopathic bulbar stricture (preoperatively assessed on a lateral view of an ascending urethrogram or urethral ultrasound), it is perfectly reasonable to try urethral dilatation over a guide wire, or optical urethrotomy for the first time treatment. Urethral dilatation over a guide wire can be performed in the office or as a day case procedure using local anesthetic gel and is unlikely to damage the urethra further as the existing spongiofibrosis is literally split in several places to the defined caliber of the dilators. This usually causes minimal urethral bleeding and a urethral catheter is not usually necessary, or, if used, can be removed the day after the procedure. Optical urethrotomy has to be performed under general anesthetic and can lead to significant trauma. This not only leads to

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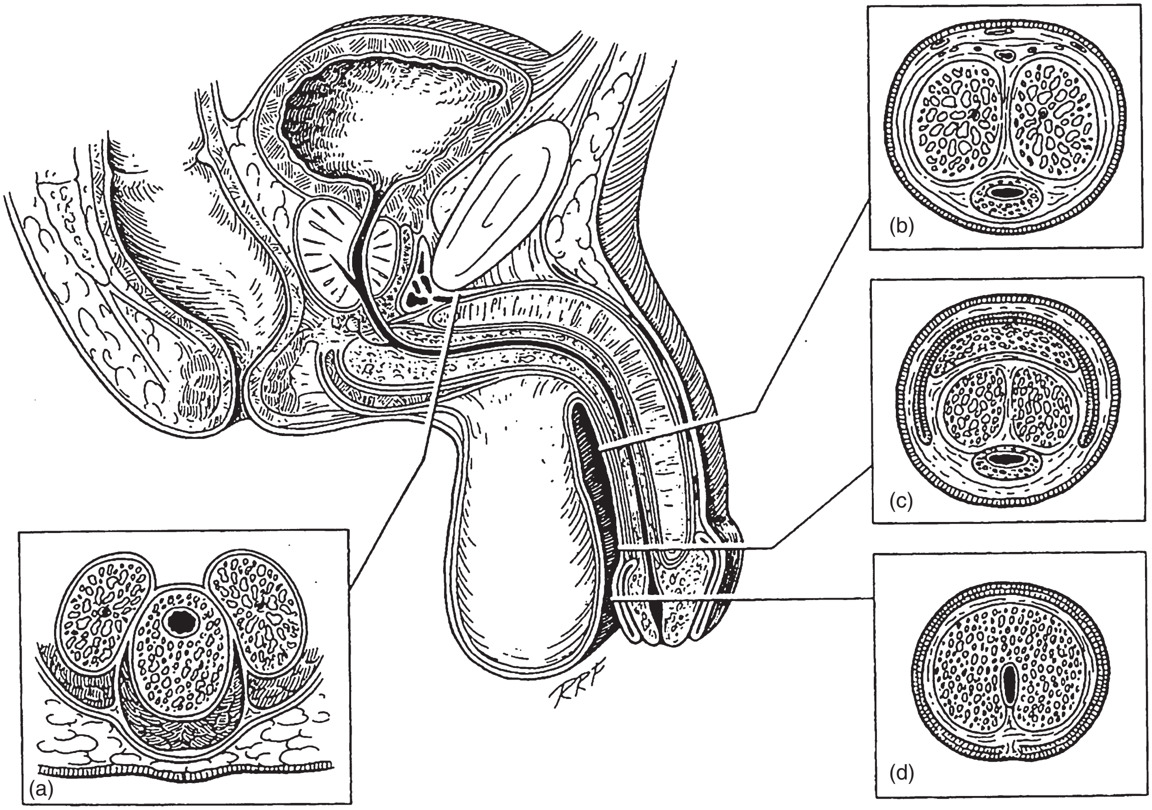

Figure 10.1 Anatomy of the urethra and the relationship to the corpus cavernosa. (a) The corpus spongiosum is thickest around the bulbar urethra and is surrounded by the bulbospongiosus muscle and on each side by the corpora cavernosa. (b) In the mid penile urethra the corpus spongiosum (urethral wall) is much thinner than the bulbar urethra. (c) The distal penile urethra at the level of the corporal heads. (d) The glanular urethra is surrounded by the spongiosum of the glans penis. (Source: Complications of interventional techniques for urethral stricture. In *Complications of Interventional Techniques*. (1996) Carson CC (ed), lgaku-Shoim, New York, p. 90.)

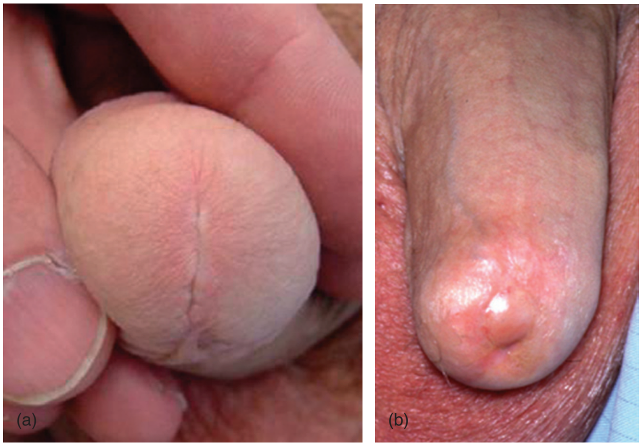

Figure 10.2 Varying degree of lichen sclerosus. (a) Very mild signs of lichen sclerosus affecting the margin of the external urethral meatus. (b) Complete loss of the coronal sulcus with fusion of the foreskin and atrophy of the glans with severe meatal stenosis and obliteration of the fossa navicularis.

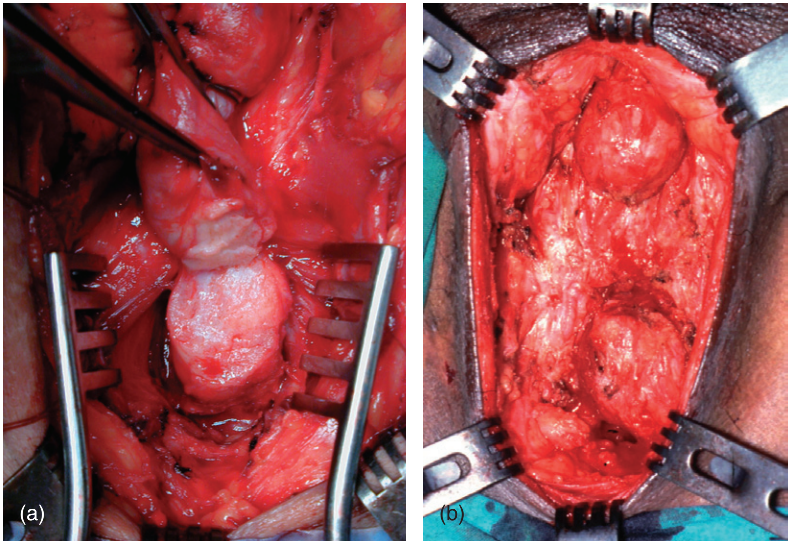

Figure 10.3 Traumatic bulbar stricture. The crush injury is causing fibrosis of the entire wall of the urethra (a), or, in more severe cases, complete absorption of the affected necrotic segment (b).

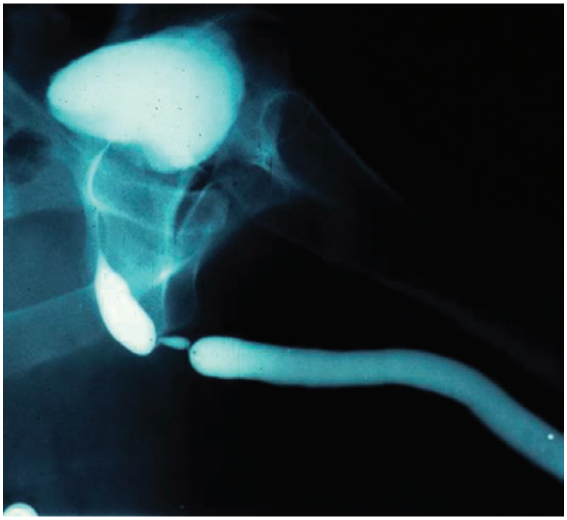

Figure 10.4 A bulbar stricture after one optical urethrotomy, leading to a longer beaded recurrent stricture.

further complications such as urinary extravasation with periurethral abscess and potential deterioration of the urethral stricture segment (Figure 10.4), but inevitably confines a patient to prolonged urethral catheterization, which is not necessary if a stricture is managed by dilatation in the first place. If endoscopic management of an idiopathic bulbar stricture fails, urethroplasty gives the best hope of long-term cure.

Assessment

Simple uroflowmetry with a prolonged "plateau"-shaped trace is diagnostic for an underlying stricture. Imaging of the urethra is performed using retrograde (ascending) and antegrade (voiding) urethrography which defines the length and position of the stricture. The presence of fistulas and diverticula can be detected on the urethrograms. Ultrasonography using a 7.5-MHz linear array transducer can provide further evaluation of the depth of spongiofibrosis.

Preoperative erectile function should also be documented.

Surgical management

The choice of operation depends on the location of the stricture and the length of the stricture. The urethral surgeon should have a number of potential procedures at his or her disposal because of the variation in the anatomy of the stricture. The aim is to reconstitute the urethra to a normal caliber which allows a normal voiding pattern with a straight urinary stream. Long-term success is achieved using procedures involving excision and anastomosis or tissue transfer techniques with flaps or grafts.

Risks

- Recurrent strictures;
- Bleeding from the corpus spongiosum;
- Fistulas;
- Hair balls if hair-bearing skin is used for the reconstruction;
- Post micturition dribbling; and
- Impotence.

Patient preparation

A review of the preoperative imaging should take place before the procedure. Preoperative antibiotics are administered together with epilation if hair-bearing skin is to be used. For any transperineal surgical procedure, whether for a bulbar urethroplasty or insertion of a bulbar artificial sphincter, our preference is to place the patient in a low lithotomy position supported by Yellow Fin boots and inflatable compression stockings (Figure 10.5).

Surgical techniques

Transperineal access to the bulbar urethra

The bulbar urethra is exposed through a midline perineal incision from the base of the scrotum to just 2 cm before the anal margin. The incision is deepened through subcutaneous fat and Colles' fascia, and the bulbospongiosus muscle is laid open in the midline. The urethra is then mobilized from its attachment by Buck's fascia to the corpora cavernosa at the level of the stricture (Figure 10.6). In idiopathic strictures, the stricture is opened dorsally and the length of the stricture assessed holding the short stricturotomy open with fine stay sutures (Figure 10.7). This approach allows the surgeon to confirm the urethrogram findings.

For pelvic fracture-related urethral strictures, the entire bulbar urethra is mobilized up to the perineal membrane having divided the perineal body.

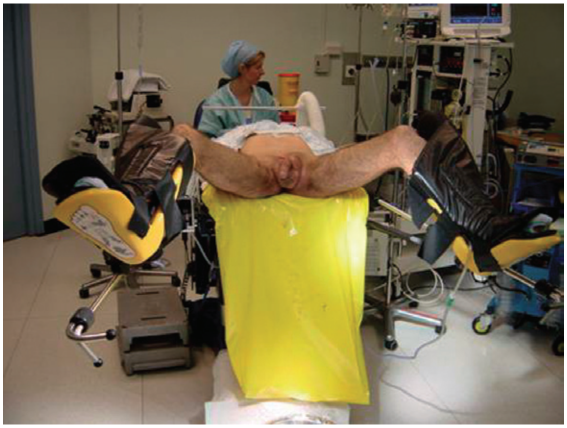

Figure 10.5 Patient in low lithotomy position.

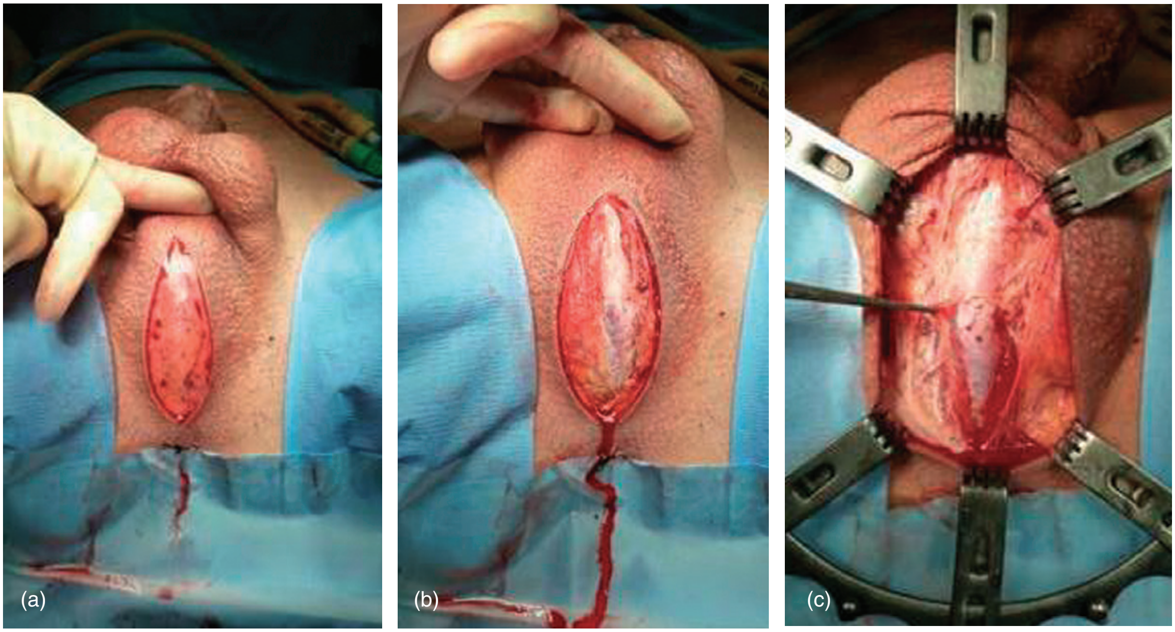

Figure 10.6 Incision of the skin and subcutaneous tissue is performed. The bulbospongiosus muscle is split in the midline.

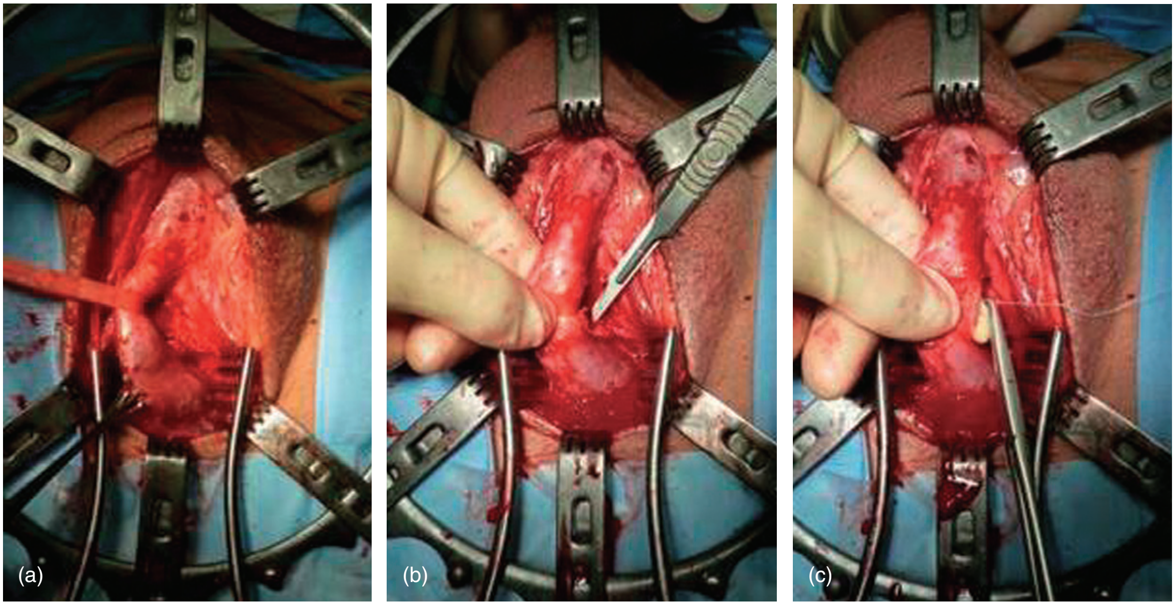

Figure 10.7 Mobilization of the bulbar urethra. A dorsal stricturotomy on to a 20-F Foley catheter at the level of the stricture is performed.

Urethroplasty for idiopathic bulbar urethral strictures

A very short stricture requires no more than a stricturoplasty whereby the longitudinal dorsal stricturotomy, which opens the healthy urethra at both ends, is closed with horizontal interrupted sutures thereby restoring the urethra to a normal caliber (Figure 10.8).

Somewhat longer idiopathic strictures (Figure 10.9), particularly if located at the junction between the mid and proximal bulbar urethra (the most common location of an idiopathic bulbar stricture), are suitable for a mucosal anastomotic approach, whereby the scarred spongiosum is excised leaving the remaining healthy ventral corpus spongiosum of the bulb intact thereby preserving the dominant bulbar arterial inflow. The mucosa is sutured with interrupted sutures with the knots inside taking a decent bite of the underlying spongiosum to avoid cutting out of the suture (5-0 polyglactin). The roof of the anastomosis is closed horizontally as before, with the suture knots outside (Figure 10.10). The urethra needs to be mobilized as for a traditional transecting anastomotic approach and the limitations of mobilization are similar. If required, corporal separation can shorten the natural curve of the mid bulbar urethra for a tension-free anastomosis of a longer stricture. After the mucosal anastomosis is complete, the healthy ventral spongiosum is buckled ventrally without ill effect. Preserving the ventral spongiosal blood flow is particularly relevant in patients who have had previous hypospadias repair as their retrograde distal blood flow is predictably impaired.

The most reliable technique for long bulbar strictures (Figure 10.11) is a patch augmentation with buccal mucosal graft which will restore the narrowed urethral caliber to normal.

Not infrequently, a longer than anticipated stricture can be revealed during the operation, as is often the case in long-standing cases, with squamous metaplasia of the proximal end occurring within a few millimeters of the veru montanum.

The nontransecting dorsal stricturotomy approach gives the surgeon flexibility and the option to adjust the surgical technique to the clinical finding.

Where possible a graft can be avoided to minimize the risk of post micturition dribbling.

In theory, a stricturotomy can be performed dorsally, ventrally or laterally, or with a combination of a dorsal and ventral approach. All have been tried. The authors prefer a dorsal stricturotomy because it is through the least vascular aspect of the urethra so there is less bleeding. There is also excellent support for the buccal mucosa graft (BMG) provided by the tunica albuginea and more

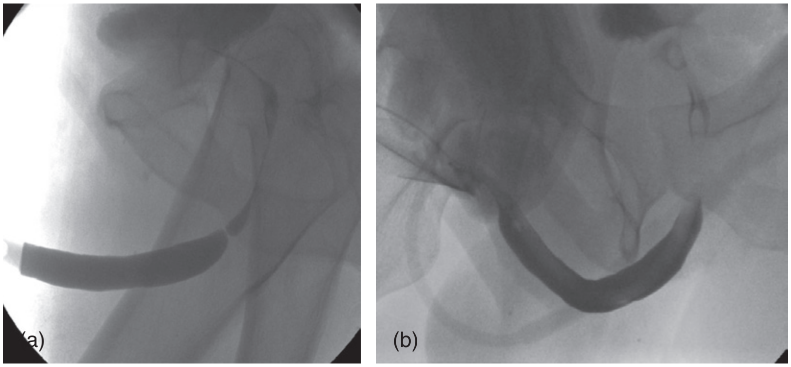

Figure 10.8 (a) Preoperative and (b) postoperative urethrogram showing a short idiopathic bulbar stricture treated by performing a stricturoplasty.

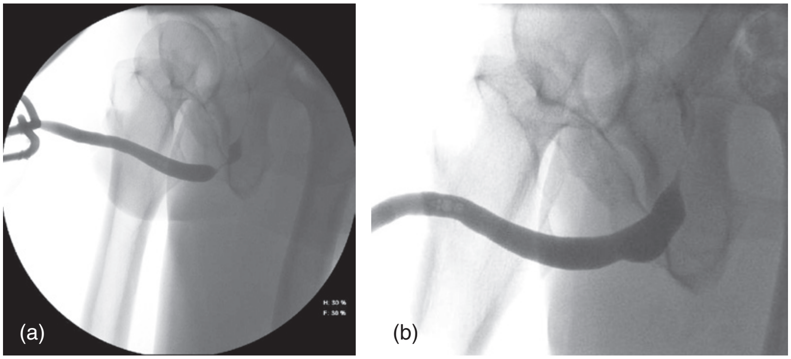

Figure 10.9 Longer idiopathic bulbar stricture treated with a mucosal end-to-end anastomosis preserving the ventral spongiosal blood flow.

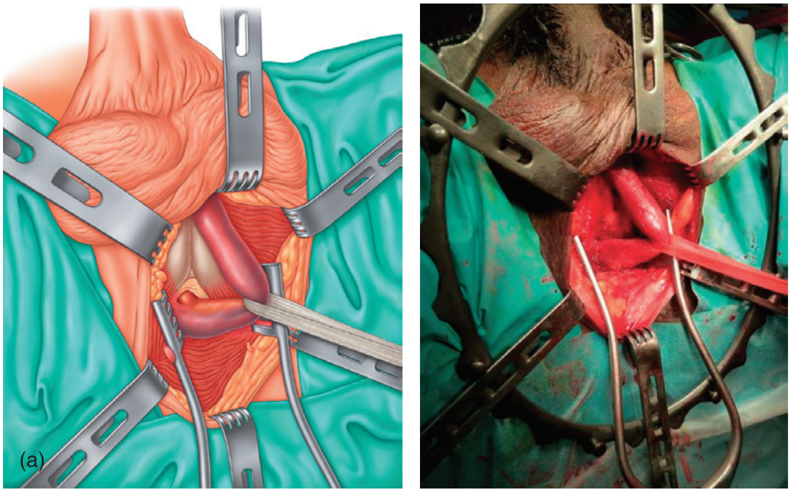

Figure 10.10 Nontransecting mucosal anastomotic bulbar urethroplasty. (a) Dorsal stricturotomy on to catheter at the level of the stricture. (b) Stay sutures placed to assess the length of the spongiofibrotic segment. (c) Interrupted anastomotic mucosal sutures with the knots inside to bring the mucosal ends together after the spongiofibrosis is excised with a knife leaving the healthy ventral spongiosum intact. (d) Horizontal closure of longitudinal dorsal stricturotomy with interrupted sutures, suture knots are placed outside. (Source: Andrich DE, Mundy AR. Non-transecting anastomotic bulbar urethroplasty: a preliminary report. BJU Int, 2012; 109:1090–1094. Reproduced with permission of John Wiley & Sons Ltd.)

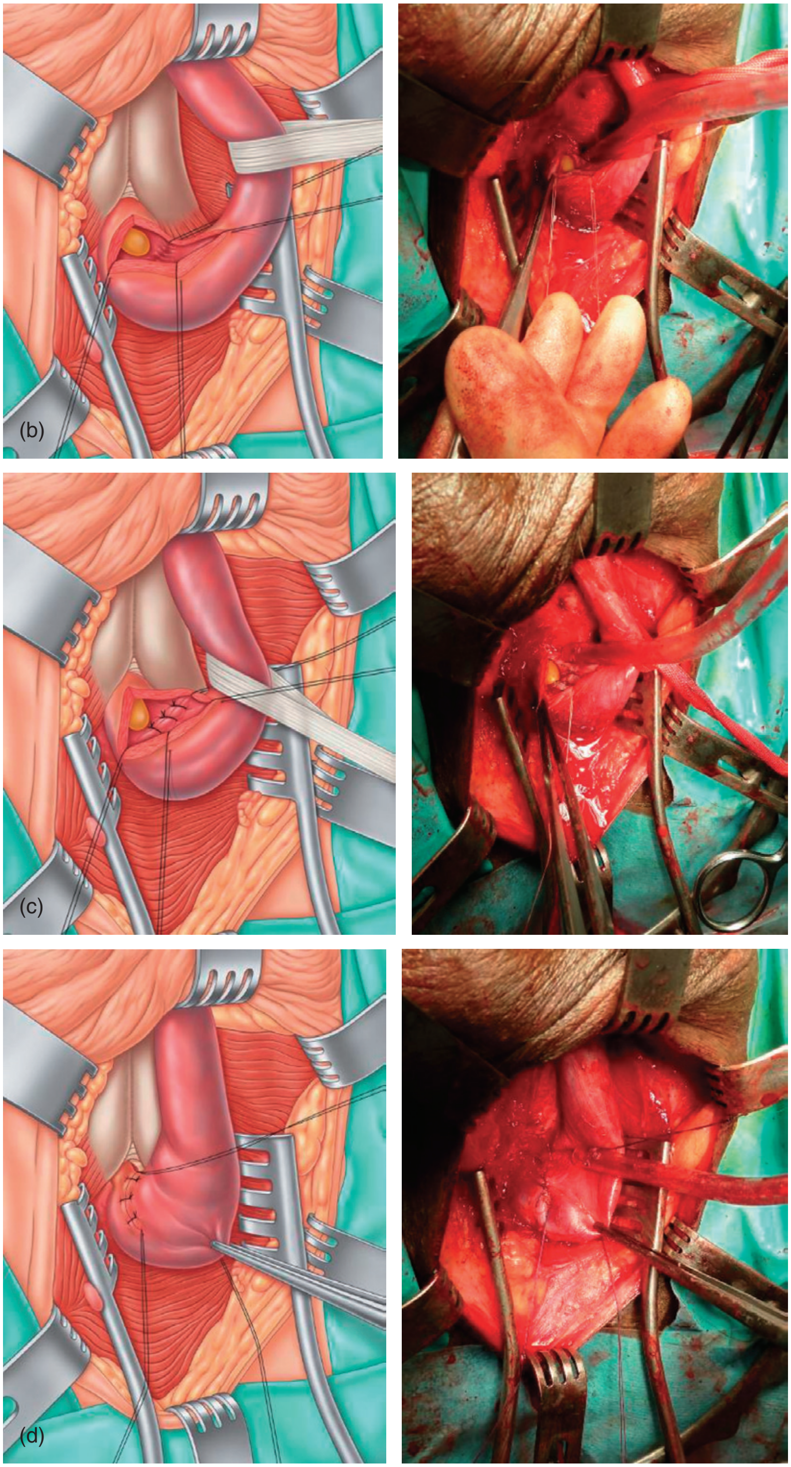

Figure 10.10 (*Continued*)

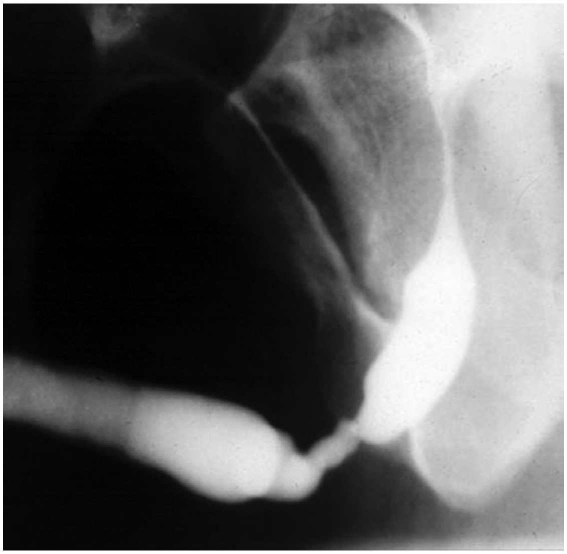

Figure 10.11 Urethrogram showing a long bulbar stricture affecting the distal and midbulbar urethra after three optical urethrotomies.

laterally from the posterior aspect of the bulbospongiosus muscle (Figure 10.12). After quilting the graft in place, the urethral margins are sutured to the margins of the graft.

In some more unusual circumstances, such as a prolonged transurethral resection of the prostate (TURP) which is associated with a bulbar stricture close to the external sphincter mechanism, a ventral patch approach may be more appropriate, because the external urethral sphincter has a horseshoe configuration. When buccal mucosa is in short supply, sublingual mucosa is a satisfactory alternative.

In complex cases, such as revision urethroplasty, and in those cases associated with infection, a pedicled penile skin flap may be more appropriate. This is usually because the conditions are not favorable for a graft and so a flap with its own blood supply gives a more secure outcome. This was the standard approach to urethroplasty 20–30 years ago but has been almost completely superseded by buccal mucosal grafting.

Urethroplasty for traumatic urethral strictures

In cases of traumatic urethral injury where there is a block of fibrosis rather than a true "stricture" (Figure 10.3) the fibrotic tissue is excised and the healthy ends are sutured together again with a spatulated anastomosis of six interrupted absorbable sutures (Figure 10.13).

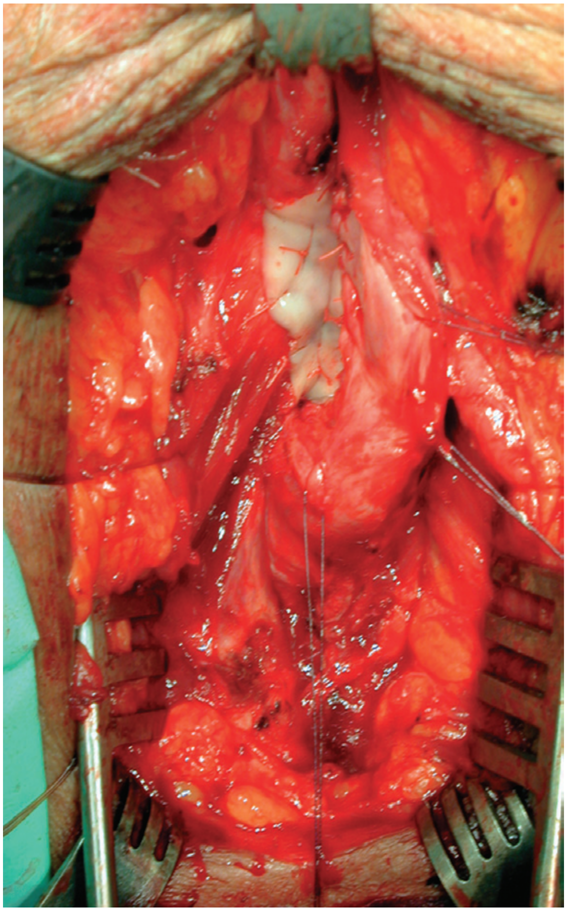

Figure 10.12 Nontransecting dorsal patch buccal mucosa graft (BMG) bulbar urethroplasty. The bulbar urethra has been mobilized. A dorsal patch BMG is quilted in place.

Occasionally, after excision of the stricture (or obliteration) a tension-free anastomosis is not possible after full mobilization of the bulbar urethra. In this case, the defect on the side of the (dorsal) spatulation can be made up by a graft, an augmented anastomotic repair (Figure 10.14).

Excision and end-to-end anastomosis will usually deal with strictures or disruptions of the bulbar urethra but may not be sufficient, on its own, to deal with all pelvic fracture-related strictures. Particularly in lateral compression pelvic fractures, the inferior pubic ramus fracture can crush or lacerate the proximal bulbar urethra to a variable degree, causing obliteration of the

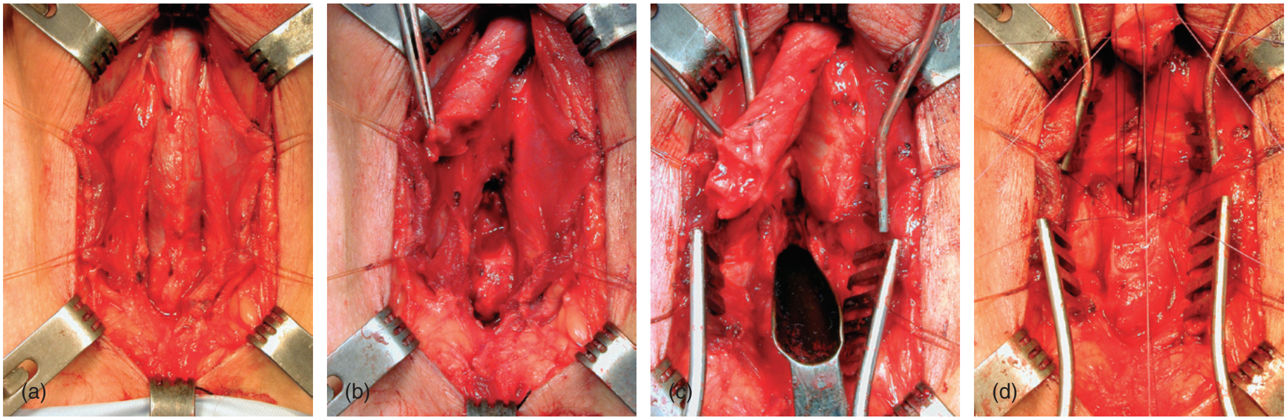

Figure 10.13 Transecting anastomotic end-to-end bulbar urethroplasty. (a) The bulbar urethra is mobilized. (b) The urethra is transected at the level of the stricture. (c) Both ends are spatulated. (d) An anastomosis is sutured with six interrupted sutures (5-0 Vicryl).

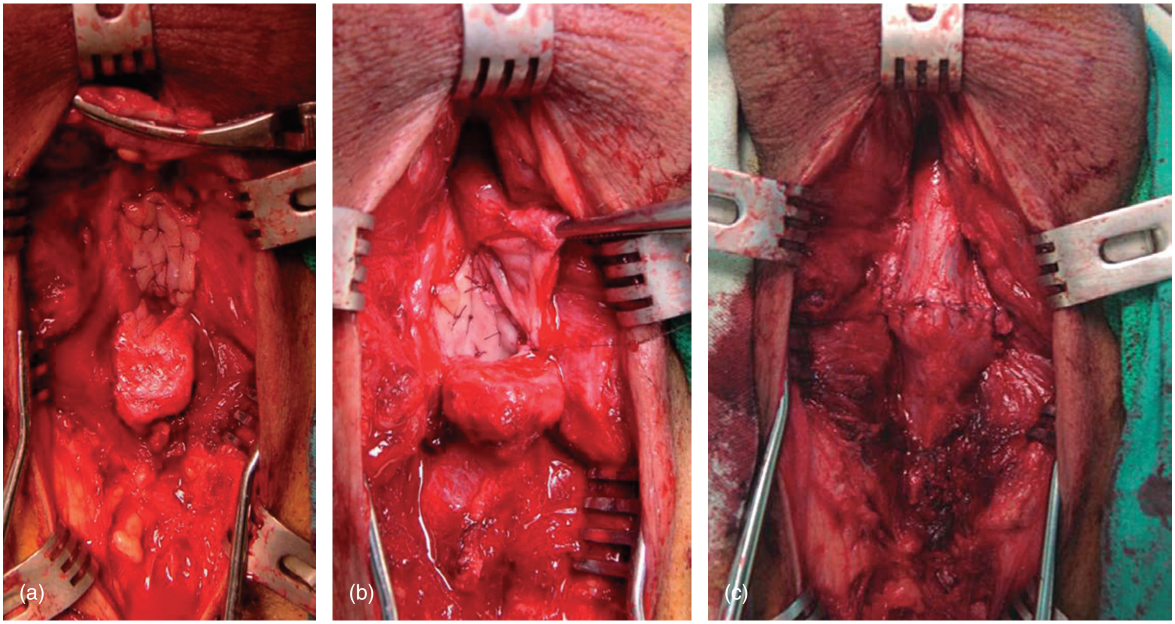

Figure 10.14 Augmented anastomotic bulbar urethroplasty with dorsal BMG patch. (a) A small patch of buccal graft fills the dorsal spatulation of both ends. (b) The ventral hemi-circumference is anastomosed with interrupted 5-0 polyglactin sutures. (c) The dorsal spatulated urethral edges are sutured to the graft.

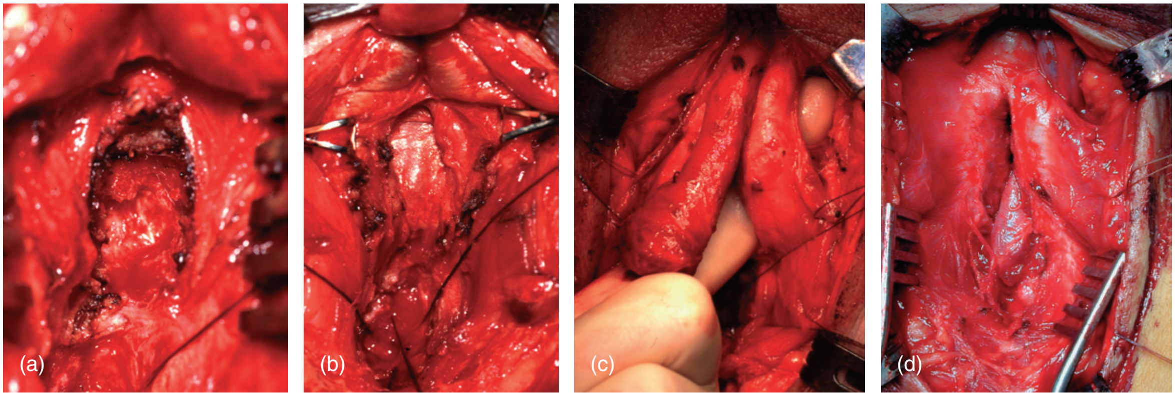

Figure 10.15 Further mobilization maneuvers of the bulbar urethra. (a) Corporal separation exposes the dorsal vein. (b) Partial inferior pubectomy. (c) Osteotomy trench to accommodate the rerouted urethra. (d) The maximum mobilization of the remaining healthy mid-bulbar urethra to bridge the gap to the apex of the prostate for a tension-free anastomosis.

membranous and proximal bulbar urethra. If the remaining length of the bulbar urethra is critically reduced, a tension-free anastomosis can be a challenge. In this instance, the natural curve of the bulbar urethra is reduced by developing the intercrural plane, which is the first cause of the natural curvature. If this alone is not sufficient, wedge resection of the inferior pubic arch is performed, which is the other anatomic component generating the natural curve of the bulbar urethra. Occasionally, because the intercrural plane can only be developed so far before the cross-circulation between the crura produces a single vascular structure, the urethra needs to be rerouted around the shaft of the crus, rather than the normal route between the crura for anastomosis to the membranous urethra, or the apex of the prostate (Figure 10.15).

The longer the stricture, the more the remaining mid-bulbar urethra has to be stretched and rerouted to reach the apex of the prostate, achieved by corporal separation and rerouting around the crus of the penis after inferior pubectomy.

In traumatic strictures, as a general rule, an anastomotic urethroplasty, excising the stricture and performing an end-to-end anastomosis of healthy urethra to healthy urethra, gives the best results with the most durable outcome and the fewest complications.

Penile urethroplasty

Penile urethral strictures are sometimes simple and related to urethral catheterization. In such circumstances an Orandi-type skin flap is entirely appropriate. In this procedure a ventral patch of penile shaft skin, directly overlying the urethra, is mobilized on its dartos pedicle and rotated in to restore the urethral caliber to normal (Figure 10.16). Lichen sclerosus is a contraindication for a skin flap repair.

More commonly, strictures of the penile urethra are caused by previous surgery for hypospadias or secondary to lichen sclerosus or they may be entirely idiopathic. For those limited to the external meatus, a meatotomy is entirely appropriate or, if only the fossa navicularis is affected, a one-stage substitution urethroplasty with BMG inlay can be performed (Figure 10.17).

The diseased urothelium and fibrosis of the fossa navicularis is excised, the glans cleft deepened and re-epithelialized with BMG and closed in one stage. However, if the stricture affects the distal penile urethra proximal to the coronal sulcus as well, it is safer to do the repair in two stages.

The problem of most salvage hypospadias surgery and surgery for lichen sclerosus is that it extends beyond the meatus and glanular urethra and more proximally into the urethra of the shaft of the penis. Here reconstruction is more difficult because the thickness of the corpus spongiosum compared to the bulbar urethra is much thinner (Figure 10.1) and therefore this is not a reliable bed for a one-stage graft repair.

In hypospadias revision the dartos layer is deficient, which would otherwise be used to cover and support a repair. In addition, it is commonly necessary to excise the neourethra and it is widely accepted that one-stage tubed repairs, whether grafts or flaps, do not do well.

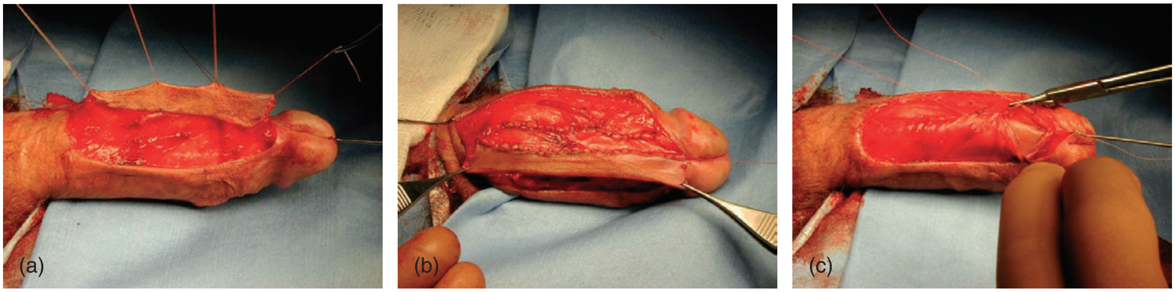

Figure 10.16 Orandi skin flap penile urethroplasty. (a) The required length and width of the skin flap is raised to augment the stricture caliber to a normal caliber of about 24–26 F. (b) Ventrally opened penile urethral edge is sutured to the skin flap margin. (c) The other skin edge is sutured to the other urethral margin inverting the mucosa.

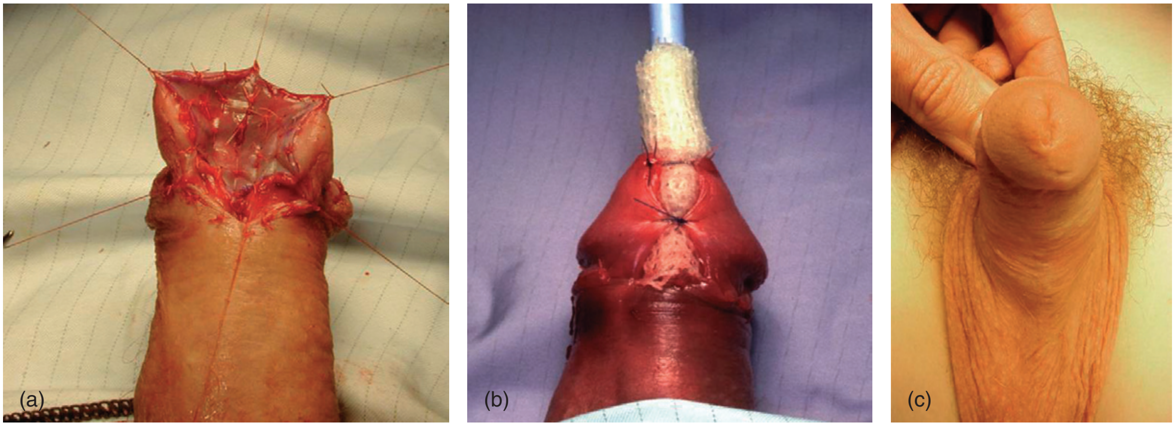

Figure 10.17 One-stage graft BMG inlay. For a distal lichen sclerosus stricture affecting the fossa navicularis only. (a) The diseased urothelium and obliterated fossa navicularis is excised and the glans cleft deepened and re-epithelialized with BMG. (b) Tie-over dressing to protect the graft for the first 3–4 days. (c) Result of reconstructed glans and meatus 3 months after surgery.

For this reason it is generally safest to repair the distal penile urethra from anywhere along the penile shaft up to the meatus in two stages. The first stage is to prepare the graft site and lay the graft on as a patch to be left exteriorized; and the second stage is to roll this neourethral strip into a tube and close the dartos and the skin of the penis around it (Figure 10.18).

The first step of the procedure is to perform a ventral skin incision over the stricture's urethral segment. The dartos layer is then mobilized in the midline and a ventral urethrotomy is made into the healthy proximal end. The old hypospadias repair skin tube is excised and the neourethral plate is created using BMG.

It is often necessary to deepen the glans cleft to be able to create a satisfactory glanular urethra and meatus. An adequate size of buccal mucosa is then harvested (Figure 10.19), supplemented by sublingual mucosa when necessary. The corpus spongiosum of the glans provides good support in the region of the glans. More proximally the graft is quilted to the underlying tunica albuginea in its mid section. On either side of the midline a slip of dartos is quilted between the graft and the tunica to make it easier to roll in at the second stage. The patient is then left with a tie-over dressing and a urethral catheter (Figure 10.20). The tie-over dressing is taken down after about 4 days and the catheter removed a week later.

The second stage is delayed for at least 4 months until the graft looks healthy, supple and generally ready for the next stage. Four months is the early limit where there may still be some hyperemia of the graft. The second stage can

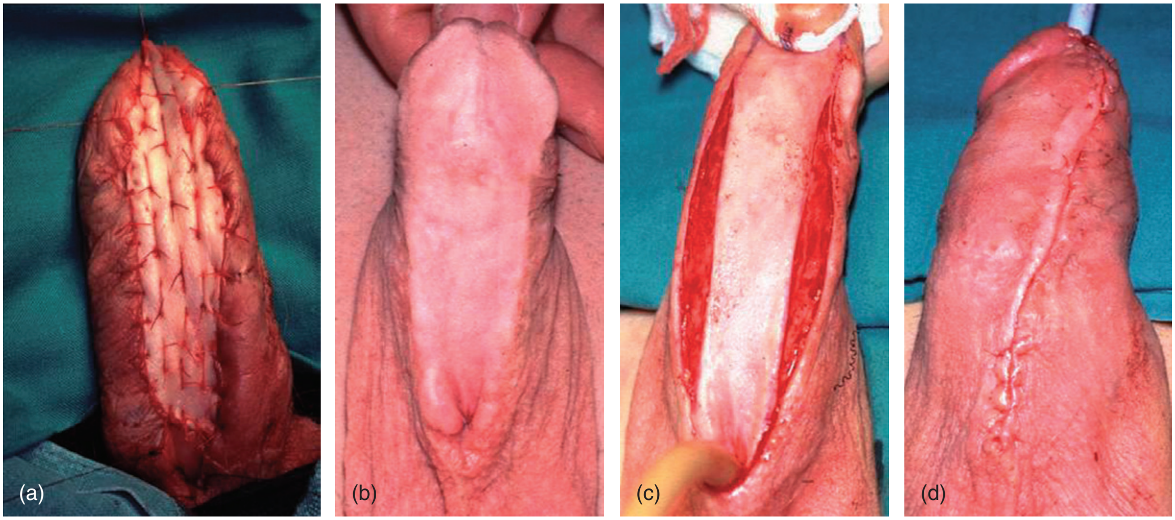

Figure 10.18 Staged penile urethroplasty. (a) First stage: shows the quilted buccal mucosal graft to replace the scarred old hypospadias skin tube repair to form the new urethral plate. (b) After 4–6 months the graft has taken well with subtle edges. (c, d) Second stage: the lateral edge of the graft is incised to retubularize the new urethra in three layers: mucosa, dartos and skin.

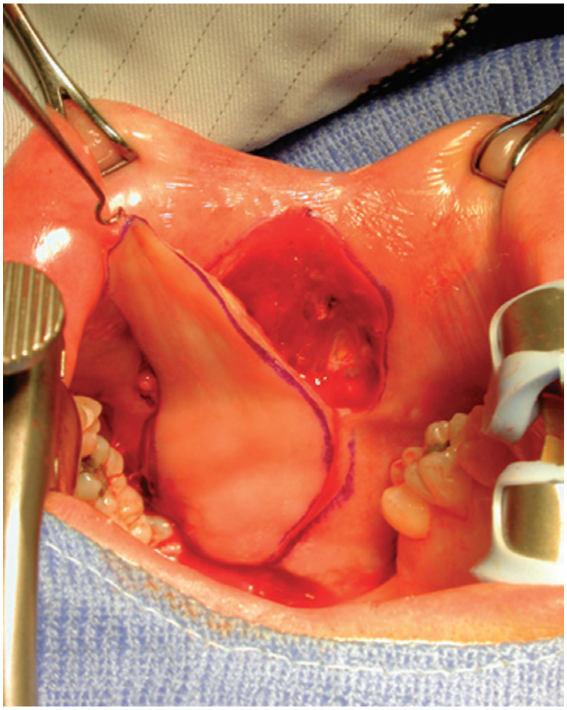

Figure 10.19 Technique of buccal mucosal graft harvest. The required size of oral mucosa is harvested: the width is ideally about 25–30 mm and the length of the graft matches the longitudinal requirement of the neourethral plate, if necessary with two buccal grafts. The graft should not be consciously stretched and not fenestrated as it is a full thickness graft. The dimension of one buccal graft is typically 6 × 2.5 cm, unless modifications of the incision are undertaken.

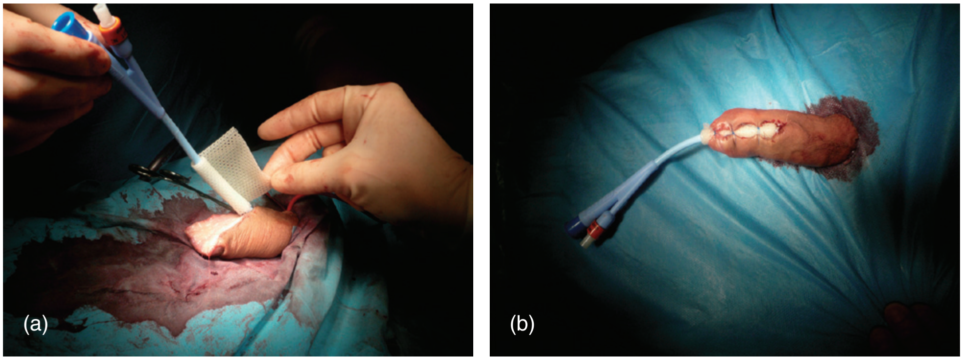

Figure 10.20 Tie-over dressing technique. (a) Mepitel™, a nonadherent silicone dressing is used to increase the diameter of the 16 F urethral catheter to about 24–26 F so that the graft is gently compressed. (b) The edges of the skin (including a bite of the graft) are approximated with a nonabsorbable dressing.

be performed at any time and indeed, as with perineal urethrostomy, some patients are so pleased to be free of obstructed voiding that they are happy to stay with the first stage for a considerable period of time if not permanently, as in the case of a perineal urethrostomy (although preoperative counseling should have covered a perineal urethrostomy treatment option to avoid unnecessary grafting).

The second stage capitalizes on having that slip of dartos tucked in under each side so that the neourethral strip can be rolled up into a tube – or, more accurately, into an oval tube. It is extremely important to make sure that the neourethral strip is wide enough. At least 2.5 cm is the authors' preferred width all the way up from the position of the urethrostomy to the top of the glans where the external meatus will be, unless the patient has a small penis, when the caliber is reduced proportionally, but never below 20 F. When the graft is surgically rolled up, it produces a tube of adequate caliber which is less than one might expect. If the buccal graft neourethral plate is narrower than 2 cm it is usually as the result of graft failure when the graft is hard and nodular. Graft failure has to be revised, starting all over again.

It is also important to close the suture line with the epithelium inverted to reduce the risk of fistulation, which is the most common complication of this type of surgery.

Distally, the margins of the glans are freshened to allow spongiosal over-closure. At the corona and below, the neourethral suture line should be covered with a dartos layer, mobilizing the dartos as widely as necessary to be able to get it into position between the neourethra and the skin closure.

As with the first stage, the catheter should stay in for a couple of weeks until the wound looks as though it has healed externally, in which case it is usually healed internally. If in doubt, a pericatheter urethrogram should be performed to confirm healing.

Salvage surgery

Salvage surgery is sometimes necessary and always challenging. The simplest form of salvage for anterior urethral strictures is simply to perform a perineal urethrostomy. Here the secret is to bring the skin down to the urethra rather than to take the urethra up to the skin in which case there is usually tension in the anastomosis and a stricture results. Therefore an inverted U-shape perineoscrotal incision is made and the skin is mobilized with the underlying dartos. The more proximal the stricture, the longer the flap has to be constructed. For a high perineal urethrostomy up to the proximal bulbar and membranous urethra an inverted U-shape skin inlay of 7–8 cm axial length may be necessary, or more if the patient is obese.

Otherwise, salvage surgery has no predefined format and the urethral surgeon will choose the best technique available for the individual patient. Generally speaking, however, with a full length stricture, a graft repair of the bulbar urethra in one stage coupled with a staged repair of the penile component of the stricture using either a graft or a flap or both is an option. Full length marsupialization, suturing the skin edge after ventral stricturotomy to the urethral edge, is used in extreme cases when no other options are available. The second stage utilizes the periurethral strip of skin for retubularization, trusting that the vascular supply of this strip will come from urethral revascularization.

Otherwise, penile skin flaps are preferred over scrotal skin flaps and buccal mucosal grafts over free skin grafts except for full thickness grafts of genital skin where genital skin is available.

Meshed, split thickness graft, staged urethral reconstruction is associated with major complications, and in particular penile curvature when the split thickness graft contracts in the healing process.

Postoperative follow-up

Follow-up of simple strictures is usually straightforward. Indeed, some surgeons use no long-term follow-up at all and just tell the patient to come back and see them if they have a problem. We prefer to obtain a urethrogram and flow rate after healing is complete around 3–4 months and then at about 1 year after surgery to see if this is normal. If the follow-up urethrogram is normal at that stage patients rarely have a problem afterwards. If it is abnormal showing significant luminal restriction, but the patient is asymptomatic (usually the caliber of a stricture has to reduce below 10 F until a patient notices lower urinary tract symptoms), they could be warned of the possibility of a further problem in the future in which case they could return for further treatment. Obviously, if they are symptomatic further treatment can be initiated there and then.

Patient reported outcome questionnaires (PROMS) for urethroplasty have recently been developed and undoubtedly will find their way into the clinical follow-up of these patients.

Artificial urinary sphincter

The AMS 800™ device produced by American Medical Systems is the most common artificial urinary sphincter (AUS) implanted. There are two alternative devices: the Zephyr™ produced in Switzerland and the Flowsecure™ produced in the UK.

Implantation of any prosthesis has to be performed under sterile conditions having ensured that the urine is sterile preoperatively. Any bacterial colonization (e.g. methicillin-resistant *Staphylococcus aureus*) should be treated with 5 days of preoperative skin preparation using chlorhexidine scrubs twice daily and nasal mupirocin (Bactroban) cream. This also reduces skin colonization of *Staphylococcus epidermidis*.

The AMS 800™ has three separate components all made of silicone and connected to each other by snap-on connectors (Figure 10.21). The device is filled with isotonic fluid. The principle is that the fluid in the cuff (red arrow in Figure 10.21) squeezes the urethra and the pressure is maintained from the pressure regulating balloon through the control pump (black arrow in Figure 10.21) to the cuff until the patient wishes to void, in which case he squeezes the pump and this reverses the fluid flow temporarily to allow voiding. A slow-release valve system within the control pump slows refilling from the balloon to the cuff sufficiently to allow time for complete bladder emptying.

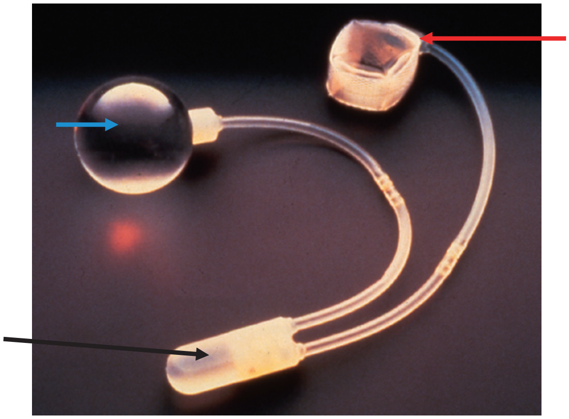

Figure 10.21 AMS 800™ artificial urinary sphincter showing the components which include the cuff (red arrow), balloon (blue arrow) and pump (black arrow).

Implantation technique

There has been recent interest in using a trans-scrotal incision to implant the prosthesis but there is a tendency for the cuff to be placed too distally and for the balloon to become misplaced and so two separate incisions – one for the cuff and the other for the balloon and the pump – seem best.

A midline perineal incision is made over the mid bulbar urethra after appropriate preoperative preparation and draping. The authors use ChloroPrep™ as an antiseptic for the skin and give the patient prophylactic antibiotics at induction and two doses postoperatively in the first 24 hours. A 20-F Foley urethral catheter is passed to confirm that the bladder outlet is of adequate caliber and this is then replaced with a 16-F silicone Foley urethral catheter which is used perioperatively and left in for the first 24 hours postoperatively. Having exposed the bulbar urethra through the skin, subcutaneous fat, Colles' fascia and bulbospongiosus it is then mobilized sufficiently from its dorsal attachment to the corpora cavernosa to allow passage of a right angle clamp that will open

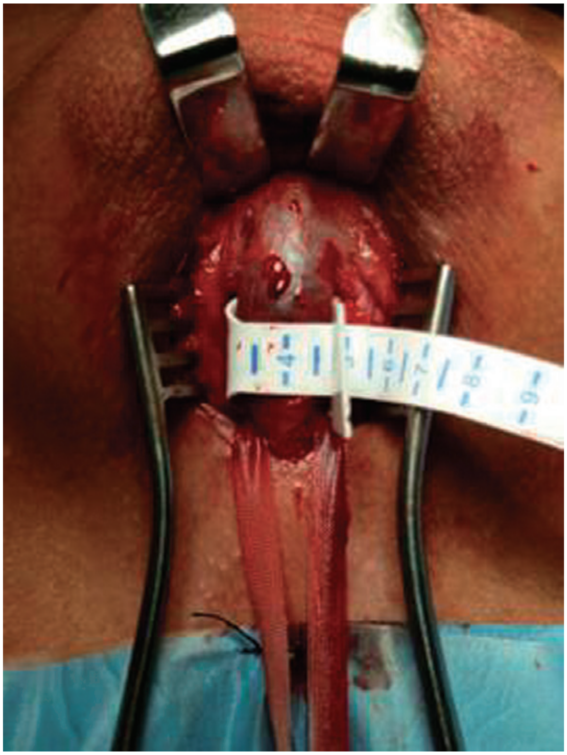

Figure 10.22 A perineal incision exposes the bulbar urethra which is mobilized off the underlying corpora cavernosa. A measuring tape can then be used to measure the circumference of the urethra. The cuff can then be implanted.

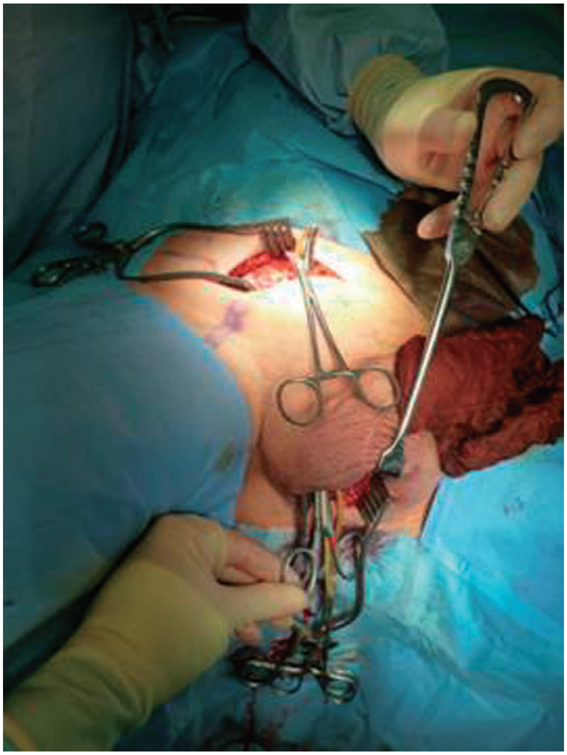

Figure 10.23 Once the cuff is snapped in place an inguinal incision is made over the deep inguinal ring and the tubing is passed up into the groin.

up a space about 1–2 cm wide to allow placement of the cuff. The measuring tape provided by the company is then passed to check adequacy of the mobilization and also to measure the circumference of the urethra. This is usually 4–5 cm (Figure 10.22). The authors never put in a cuff smaller than 4.5 cm to ensure that it will always be possible to pass an endoscope through the urethra postoperatively.

For a bulbar urethral sphincter implant the pressure regulating balloon is almost always at a 61–70 cm H_2O pressure range. Having decided on the cuff size and pressure range the components are primed with isotonic fluid (the authors use a solution of 57 mL Omnipaque in 60 mL sterile water to allow easy postoperative visualization of the components) using the purpose-built needles provided by the company. Air is evacuated from all of the components, primed with isotonic fluid and the tubing cross-clamped with rubber-shod mosquito clips.

The pump is deactivated before its tubing is clamped. The deactivation is achieved by pressing on the button situated over the valve system. In this way a small plug is pushed into the valve system to stop it working. Fluid cannot therefore move between the balloon and the cuff, The cuff is therefore kept empty to allow swelling and tenderness around the operative sites to resolve sufficiently before the device is activated by squeezing the pump to dislodge the plug.

When all of the components are primed, the cuff is first implanted, wrapped round the urethra and snapped into place. The tubing is then passed up alongside the urethra and the spermatic cord into the groin (Figure 10.23). The groin wound is centered over the deep inguinal ring and dissected deeper to develop an extraperitoneal intra-abdominal plane. The pressure regulating balloon is then passed through into this space (Figure 10.24) and the balloon is filled with 20–22 mL of the isotonic filling

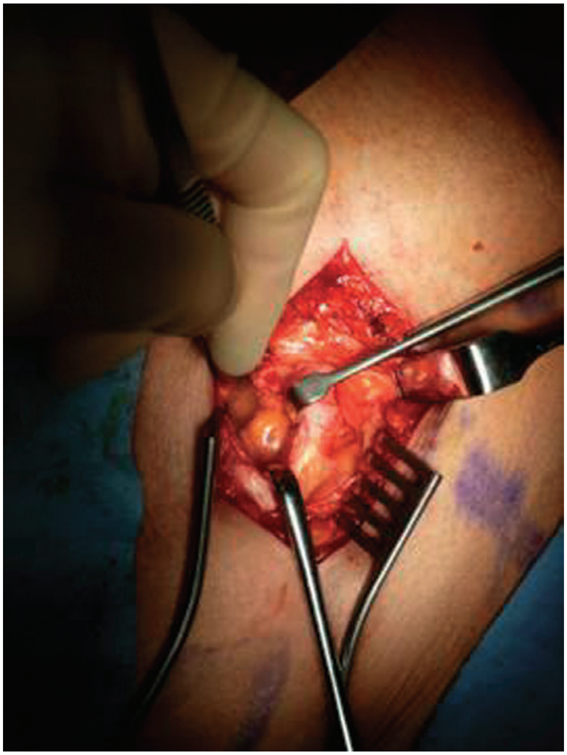

Figure 10.24 An extraperitoneal space is created for the balloon. The balloon is then passed into the space.

solution. The tubing is then clamped off as close as possible to the balloon and the tubing itself trimmed to length. One or two sutures will close off the external oblique aponeurosis.

The cuff tubing passed up from the groin is likewise trimmed to length. Then, through the inguinal incision, a plane is created at the neck of the scrotum into a dartos pouch. When a dartos pouch has been created down to the most dependent part of the scrotum the pump is passed down into it (Figure 10.25). If it is in the right place the deactivation button is clearly visible through the skin and the device is easily manipulated separately from the testicle and spermatic cord. If it is not in the correct place it will become adherent to the testicle and difficult to manipulate postoperatively. When the pump is in position the tubing above it is clamped through the skin with Babcock atraumatic tissue forceps to hold it in position during the subsequent manipulation (Figure 10.26). Its tubing is likewise trimmed to length.

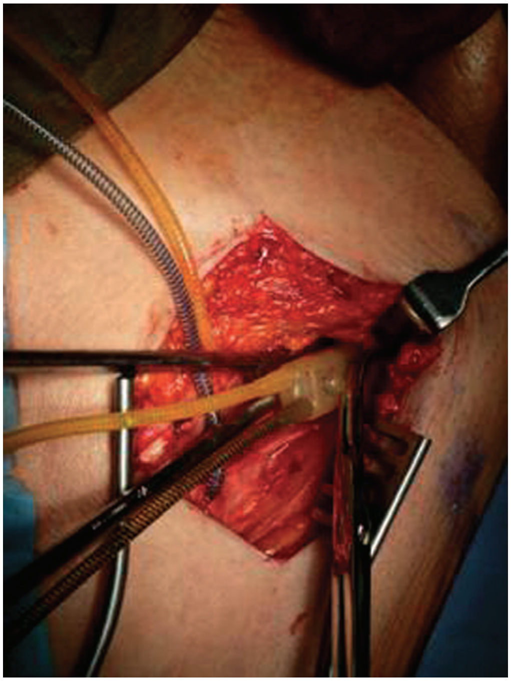

Figure 10.25 The pump is passed down into a dartos pouch created in the scrotum.

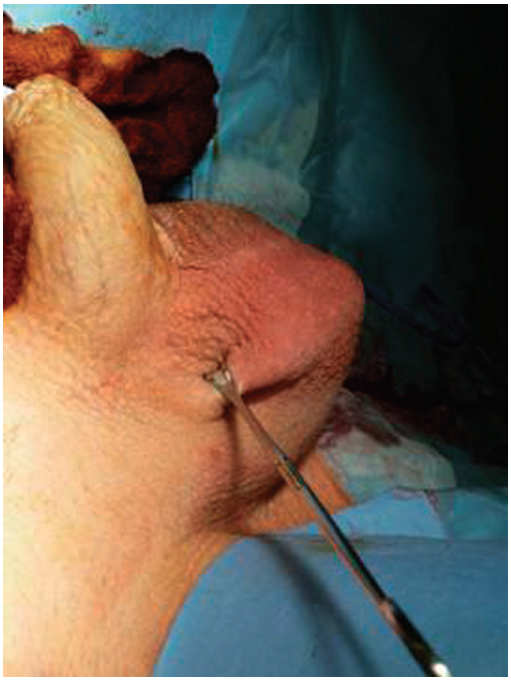

Figure 10.26 Babcock tissue forceps hold the pump in position.

With all of the component parts in place and the tubing cut to the appropriate length such that it will connect comfortably without any redundant tubing but also without any tension, the color-coordinated components are snap-connected together using the quick connect system and the purpose built pliers provided by the company. It is important not to introduce any air or blood or extraneous material into the ends of the tubing during this connection process and so the end of the tubing must be kept clean and washed clear of these potential contaminants throughout the connection procedure. After connection the wounds are closed in layers. A wound drain should not be used to avoid the risk of contamination.

Prophylactic antibiotics are continued for 24 hours. The catheter is removed on the first postoperative morning and the patient is seen for follow-up and the device activated when it is possible to squeeze the pump without causing undue discomfort, which is usually 4–6 weeks postoperatively. It is a good idea to leave the activation until the postoperative edema around the pump has completely resolved so as to be sure that there is no infection of the device, which commonly presents as low grade grumbling discomfort, swelling and redness.

Copious washing of the wounds during the implantation procedure with antibiotic solution is a good idea although this has recently been superseded since the development of the Inhibizone antibiotic coating of the device – the balloon excepted. We therefore reserve antibiotic wash for just the balloon and the implantation site and the intra-abdominal extraperitoneal space created for it.

11

Surgical Treatment of Penile Cancer

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Introduction

Penile cancer is a rare malignancy with a higher incidence in developing countries. The age standardized incidence of 0.3–1.0 per 100,000 in Western Europe and the USA has remained stable over the years. In contrast, the incidence in Paraguay and Uganda is 4.2–4.4 per 100,000. The majority of the tumors are squamous cell carcinomas located on the glans penis or foreskin. The common risk factors for penile cancer are listed in Table 11.1.

The management of penile cancer depends on the stage (Table 11.2) and location of the tumor and the current consensus is that penile cancers should be treated by undertaking penile preserving surgery when possible. Surgical amputation of the penis in the form of a partial or total penectomy is now considered as overtreatment for distal lesions but remains a surgical option for advanced disease involving the penile shaft. A number of studies have demonstrated that penile preserving surgery is oncologically safe and, although there is a slightly higher local recurrence rate, the long-term prognosis remains unchanged once the recurrence is excised. Moreover, the traditionally held 2-cm margin between tumor and normal tissue is now considered unnecessary and excessive. This has led to a variety of surgical treatments, which can result in tumor-free margins without the need to remove excessive penile tissue. Men can therefore preserve sexual function and void standing up. All tumors that are not invading into the corpus cavernosum are potential candidates for penile preserving surgery. Treatment can consist of surgery alone or a combination of surgery and other ablative techniques such as laser. The defects resulting from the removal of the penile lesions are reconstructed using skin grafts although smaller lesions can be left to heal by secondary intention or primary closure.

Clinical features

The majority of penile neoplasms are squamous cell carcinomas located on the glans penis (48%) or prepuce (21%). These distal tumors may be concealed due to the presence of a phimosis and these patients present with a palpable mass under the foreskin associated with bleeding or discharge from the preputial space. In more advanced cases these tumors invade the corpus cavernosum and the corpus spongiosum resulting in urethral obliteration. Often these tumors are fungating masses by the time the patient presents for treatment. A clinical assessment of the inguinal regions will determine whether the inguinal lymph nodes are palpable (cN+ disease) or impalpable (cN0 disease).

Investigations

Preoperative staging of the primary tumor is aided by the use of magnetic resonance imaging (MRI). By inducing an artificial erection using intracavernosal prostaglandin, the extent of the distal tumor can be visualized. This technique is useful in that it can demonstrate involvement of the distal corpus cavernosum. An additional computed tomography (CT) scan is performed to detect the presence of inguinal or pelvic lymphadenopathy and distant metastatic disease.

Atlas of Male Genitourethral Surgery: The Illustrated Guide, First Edition. Edited by Asif Muneer, Manit Arya, and Gerald Jordan.

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Table 11.1 Common risk factors for penile cancer

Phimosis
Smoking
Human papillomavirus (HPV) infection (HPV subtypes 16 and 18)
Age
Lichen sclerosus

Table 11.2 2009 TNM classification of penile cancer

T-	Primary tumour		
	TX		Primary tumour cannot be assessed
	T0		No evidence of primary tumour
	Tis		Carcinoma *in situ*
	Ta		Non-invasive verrucous carcinoma, not associated with destructive invasion
	T1		Tumour invades subepithelial connective tissue
		T1a	Tumour invades subepithelial connective tissue without lymphovascular invasion and is not poorly differentiated or undifferentiated (T1G1-2)
		T1b	Tumour invades subepithelial connective tissue with lymphovascular invasion or is poorly differentiated or undifferentiated (T1G3-4)
	T2		Tumour invades corpus spongiosum/corpora cavernosa
	T3		Tumour invades urethra
	T4		Tumour invades other adjacent structures
N-	Regional lymph nodes		
	NX		Regional lymph nodes cannot be assessed
	N0		No palpable or visibly enlarged inguinal lymph node
	N1		Palpable mobile unilateral inguinal lymph node
	N2		Palpable mobile multiple or bilateral inguinal lymph nodes
	N3		Fixed inguinal nodal mass or pelvic lymphadenopathy, unilateral or bilateral
M-	Distant metastases		
	M0		No distant metastasis
	M1		Distant metastasis

2009 TNM pathological classification of penile cancer
The pT categories correspond to the T categories. The pN categories are based upon biopsy, or surgical excision.

pN-	Regional lymph nodes:	
	pNX	Regional lymph nodes cannot be assessed
	pN0	No regional lymph node metastasis
	pN1	Intranodal metastasis in a single inguinal lymph node
	pN2	Metastasis in multiple or bilateral inguinal lymph nodes
	pN3	Metastasis in pelvic lymph node(s), unilateral or bilateral or extranodal extension of regional lymph node metastasis
pM	Distant metastases	
	pM0	No distant metastasis
	pM1	Distant metastasis
G	Histopathological grading	
	Gx	Grade of differentiation cannot be assessed
	G1	Well differentiated
	G2	Moderately differentiated
	G3-4	poorly differentiated/undifferentiated

(Source: Sobin L, Gospodarowicz M, Wittekind C. TNM Classification of Malignant Tumours, 7th Edn. 2010, pp. 240–1. Reproduced with permission of John Wiley & Sons Ltd)

Surgical treatment of premalignant penile lesions, Tis and Ta tumors

Clinical features

Premalignant lesions of the penis commonly affect the foreskin and glans penis. These lesions are either secondary to chronic inflammation (e.g. lichen sclerosus, leukoplakia) or related to human papillomavirus (HPV) infection (erythroplasia de Queyrat, giant condyloma, Bowen's disease). Penile intraepithelial neoplasia (PIN) ranges from mild or moderate dysplasia (PIN I and II) to severe dysplasia (PIN III) which amounts to carcinoma *in situ* also eponymously known as erythroplasia de Queyrat when it is limited to the glans penis.

Surgical management

The initial management of lichen sclerosus of the foreskin and glans penis using topical corticosteroids may be unsuccessful, necessitating a circumcision. Similarly, Tis may be refractory to the use of topical chemotherapy (5-FU) or immunotherapy (imiquimod). As there is no deeper invasion into the subepithelial tissues, extensive lichen sclerosus and recurrent Tis lesions which have failed topical treatment are amenable to partial or total glans resurfacing which involves the removal of the glans epithelium with the subepithelial tissue. The denuded glans is then covered with a split thickness skin graft. In order to ensure that there is no deeper invasion into the glans spongiosum, separate deep biopsies are taken from the glans penis as there is a risk of deeper invasion with more extensive Ta lesions (Figures 11.1, 11.2, 11.3 and 11.4).

Surgical risks

- Graft loss due to underlying hematoma formation;
- Urethral stenosis;
- Loss of glans sensation.

Postoperative care

The following postoperative dressings can be used for any of the penile preserving procedures that utilize a split skin graft. The authors' preference is to use either a silicone dressing (Mepitel®) followed by a dressing gauze and a tie-over dressing using 4-0 monofilament sutures. Alternatively, a proflavine soaked gauze tie-over dressing can be used. These dressings can be removed after 7–10 days and if the graft has taken adequately the catheter is removed. Often there is a "mulberry" appearance to the neoglans but this does settle with time. Small collections of blood or exudate can be punctured and released.

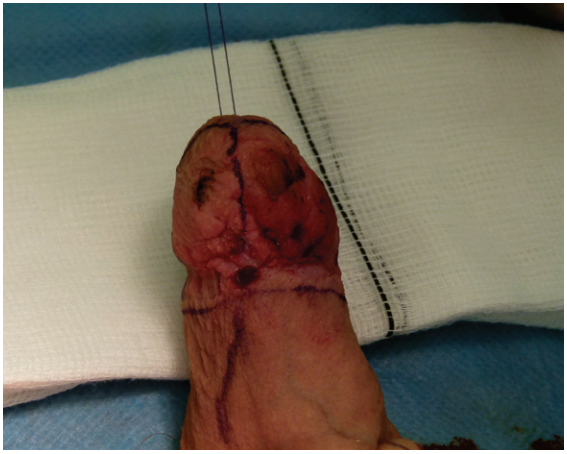

Figure 11.1 A noninvasive verrucous carcinoma of the penis is marked into quadrants. Proximally, the incision extends to the circumcoronal area as for a standard circumcision. If the patient has not been previously circumcised then this needs to be performed as part of the procedure. A tourniquet is applied to the base of the glans penis.

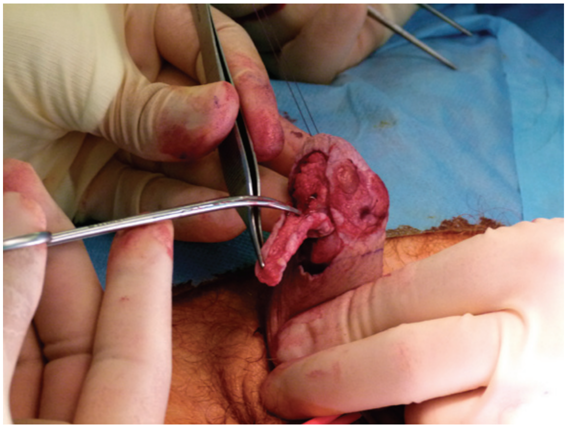

Figure 11.2 A plane is carefully developed between the corpus spongiosum and subepithelial tissue starting from the urethral meatus to just beyond the coronal sulcus. Each quadrant is removed and the specimen is orientated for histological analysis by marking the proximal and distal margins. The tourniquet is released to allow hemostasis. The main bleeding points are cauterized or oversewn using 5-0 absorbable sutures. Complete hemostasis is achieved once the split thickness skin graft is applied followed by the dressings.

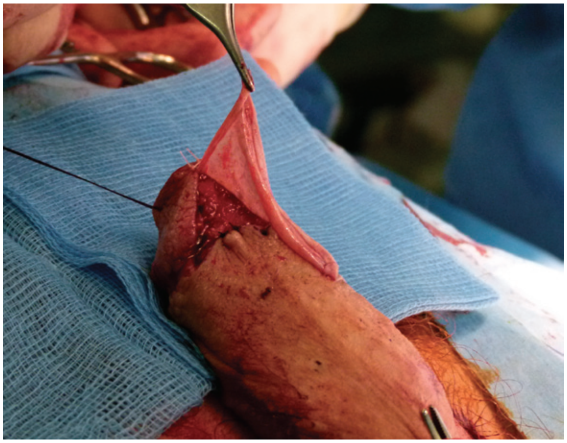

Figure 11.3 A split thickness skin graft (thickness 0.012–0.016 inch) is harvested using a dermatome from the upper thigh. The graft is sutured to the denuded glans. The graft can be perforated before suturing to the denuded glans using a combination of 5-0 and 6-0 absorbable polyglactin sutures. Proximally, the graft is sutured to the penile shaft skin using 4-0 and 5-0 absorbable sutures and distally to the urethral meatus using 5-0 polyglactin sutures. A few tacking sutures are placed subcoronally in order to create a new coronal sulcus.

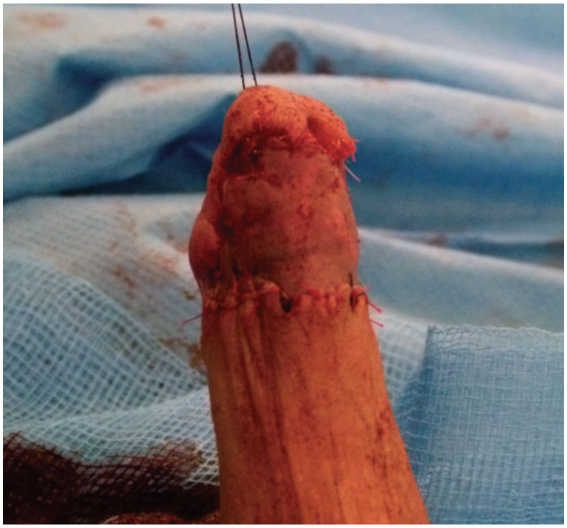

Figure 11.4 6-0 quilting sutures are placed at 1-cm intervals over the glans penis ensuring that they are bedded down flat and do not bunch up the graft. The tourniquet is then removed. A urethral catheter is inserted. Dressings are applied and sutured in place using a tie-over dressing.

Small invasive localized penile cancer (≥T1)

Clinical features

Penile tumors that are located on the inner prepuce and glans corona can be excised by performing a radical circumcision combined with a wide local excision of the tumor from the glans penis. Provided that patients are followed up very closely in order to detect any local recurrence, this technique preserves penile length with an excellent cosmetic outcome (Figures 11.5, 11.6, 11.7 and 11.8).

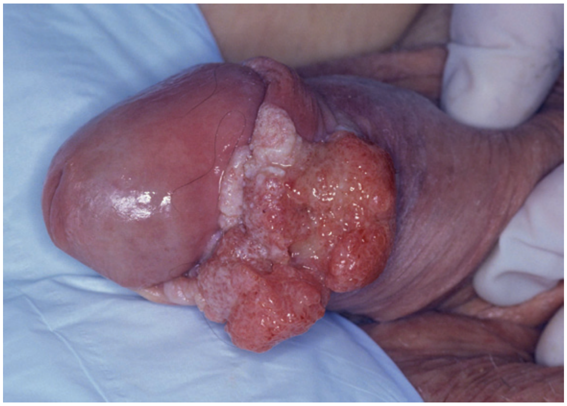

Figure 11.5 Squamous cell carcinoma located on the inner prepuce and extending to the glans corona.

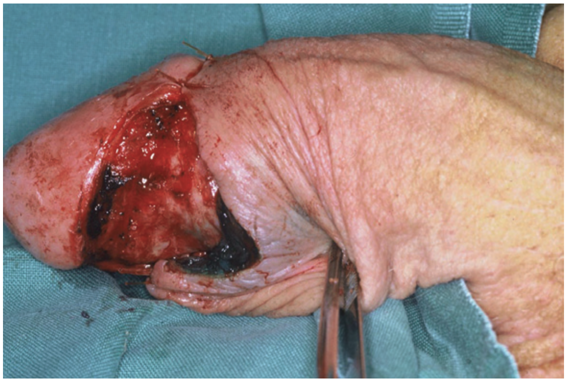

Figure 11.6 Excision of the tumor together with the deeper penile fascia to the level of Buck's fascia. The glans corona is also excised in order to obtain a tumor-free margin.

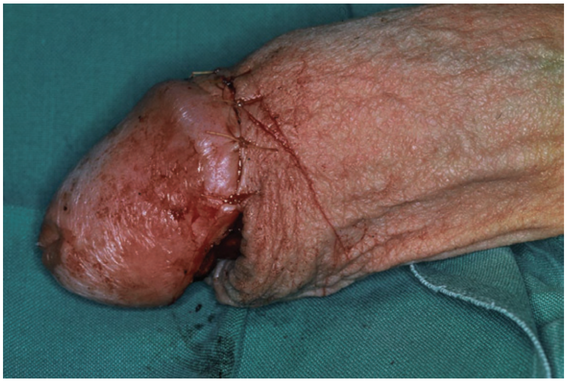

Figure 11.7 A radical circumcision is performed leaving an area of redundant outer preputial skin to cover the glans defect. The outer preputial skin is sutured to the glans using a combination of 4-0 and 5-0 absorbable sutures.

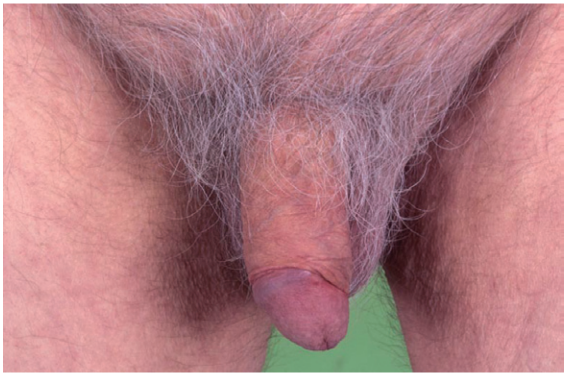

Figure 11.8 Postoperative appearance following the wide local excision and circumcision.

Larger invasive tumors of the glans penis (T2 lesions into corpus spongiosum)

Glansectomy

In patients with a large invasive tumor limited to the glans penis, glansectomy followed by reconstruction using a split skin graft is a viable and safe option. Again, this achieves the goal of tumor resection and adequate maintenance of both the penile length and erectile function (Figures 11.9, 11.10, 11.11, 11.12 and 11.13).

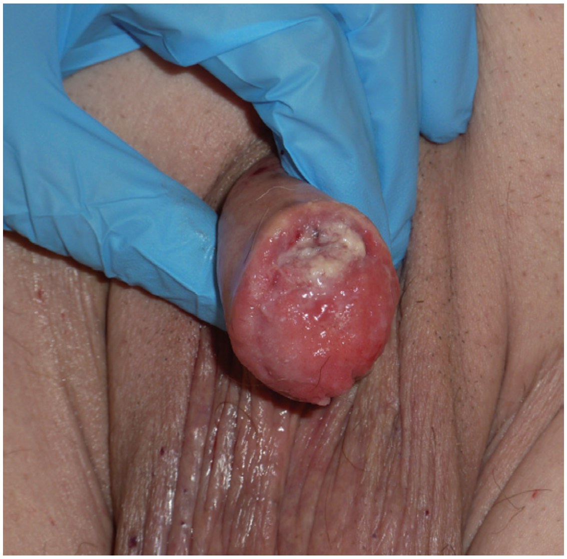

Figure 11.9 Stage T2 penile cancer limited to the glans penis and inner prepuce. Preoperative staging using MRI confirms that the distal corporal tips are not involved by the tumor.

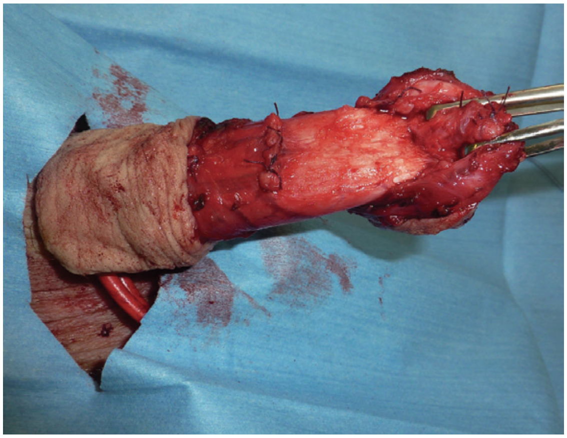

Figure 11.10 A circumcoronal incision is performed on the outer penile shaft skin. Dissection down to the level of Buck's fascia is performed. The plane between the glans and Buck's fascia can be developed for lesions that are well clear of the tunica albuginea. For lesions which are extending deeper, Buck's fascia is elevated and the neurovascular bundle is isolated and divided. Buck's fascia fuses with the corporal tips just distal to the glans corona. The dissection continues until the entire glans is removed. The urethra is transected. Further biopsies are taken from the corporal tips and a "doughnut" from the urethra is sent for histologic analysis to ensure that there is no residual tumor. The penile shaft skin is sutured to the tunica albuginea leaving approximately 2 cm of the neoglans exposed.

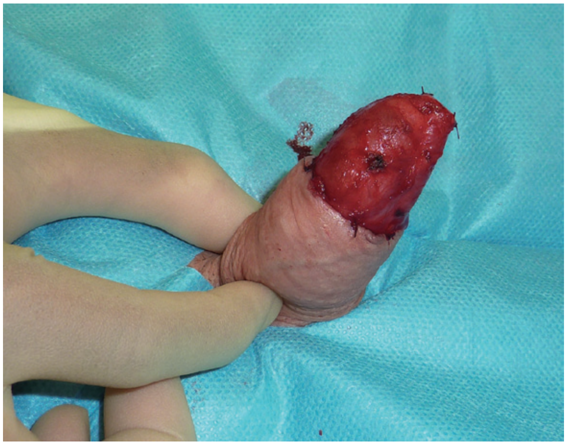

Figure 11.11 The glans is completely dissected off the corporal heads. The penile shaft skin is sutured to the tunica albuginea approximately 2 cm from the tip of the neoglans using 4/0 polyglactin sutures. The urethra is spatulated both dorsally and ventrally and sutured using 5/0 polyglactin sutures. The bed of the neoglans is now ready for the skin graft.

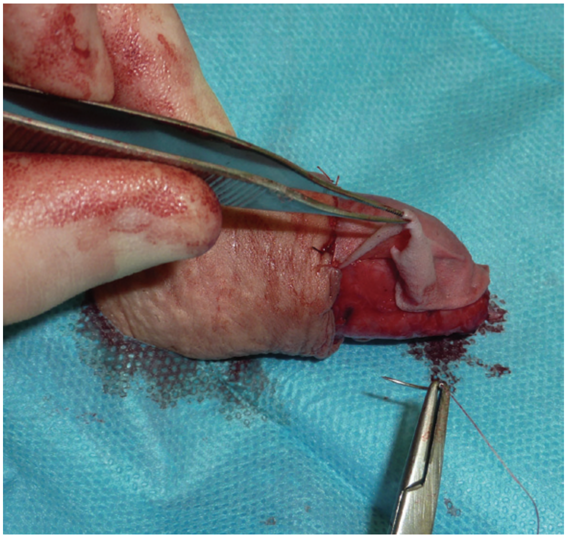

Figure 11.12 An STSG is sutured to the exposed neoglans and quilted using 5-0 and 6-0 polyglactin sutures. The spatulated urethra is sutured to the graft.

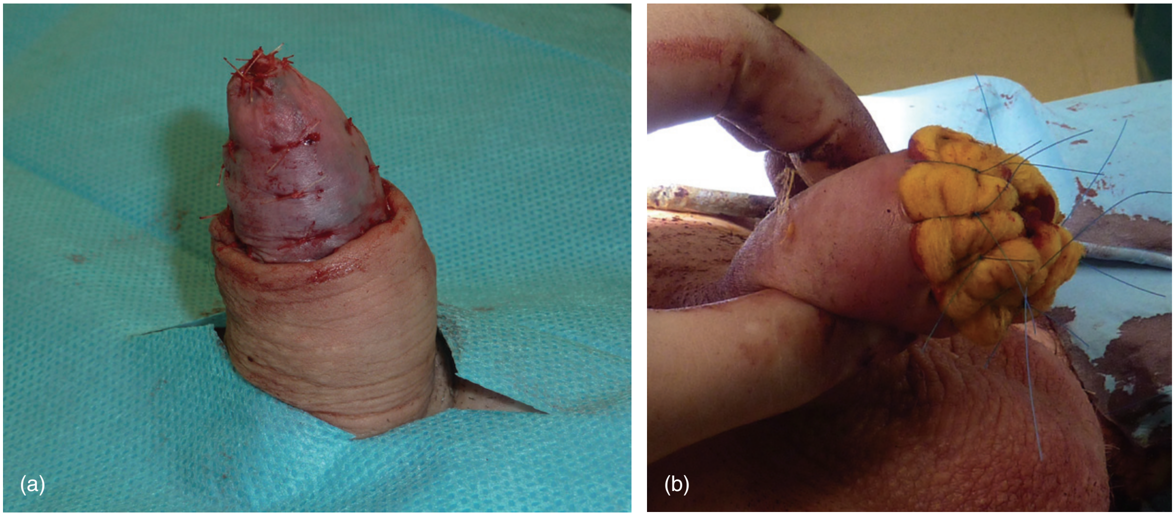

Figure 11.13 (a) Final postoperative appearance of the neoglans following glansectomy and split skin graft and after quilting the graft. (b) An alternative tie-over dressing using a Proflavine wool dressing and 4/0 monofilament sutures does not require quilting of the split skin graft and can be removed after 7–10 days.

Partial and total penectomy

Clinical features

Penile tumors that invade into the corpora cavernosa must be treated by partial or total amputation. In performing a partial amputation care must be taken to leave enough length on the penile stump in order to allow the patient to void while standing with the urinary stream passing over the scrotum without difficulty, otherwise a perineal urethrostomy may be the preferred option.

Surgical management

A partial penectomy can be performed with or without the use of a skin graft to reconstruct a neoglans. The simplest procedure involves ligating the dorsal neurovascular bundle and transecting the corpora cavernosa proximally. The penile shaft skin is then used to cover the stump (Figures 11.14, 11.15, 11.16, 11.17, 11.18, 11.19 and 11.20).

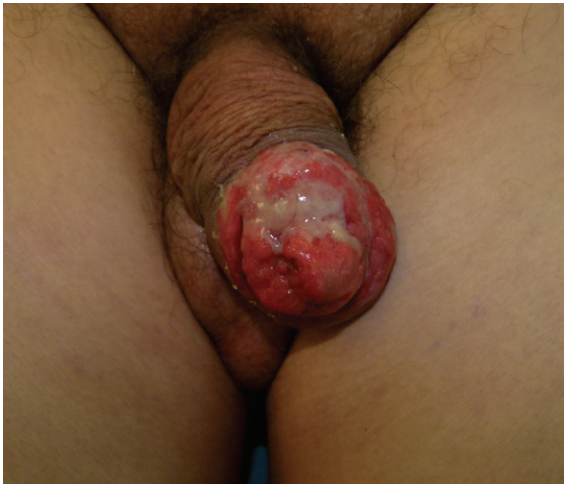

Figure 11.14 Extensive T3 penile tumor invading into the corpora cavernosa.

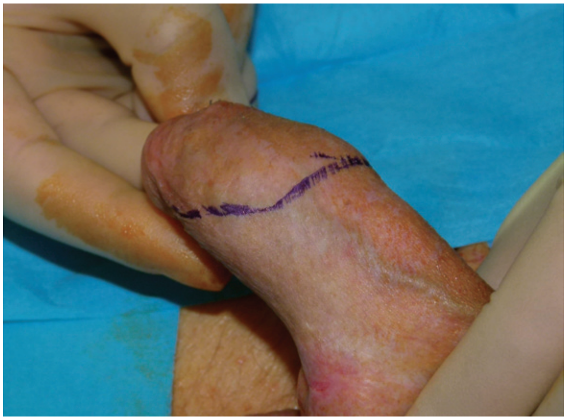

Figure 11.15 A circumferential incision of the penile shaft skin is performed. A longer flap of penile shaft skin is left on the ventral skin.

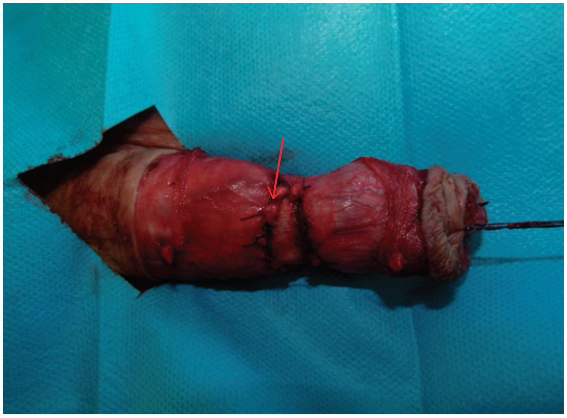

Figure 11.16 The neurovascular bundle is ligated (red arrow). The tunica albuginea is exposed at the level of transection ensuring a clear margin from the neoplasm.

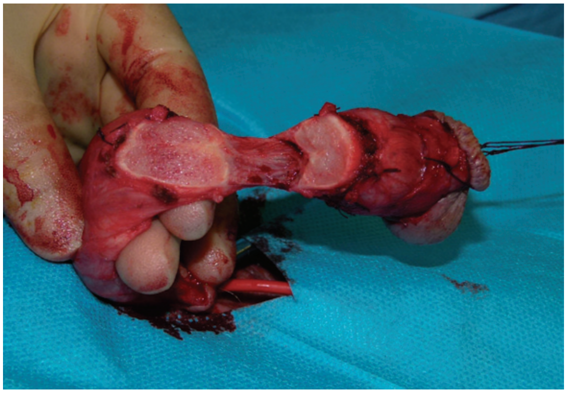

Figure 11.17 The corpus cavernosum is transected leaving a longer urethral stump. The corpus cavernosum is oversewn with either 2-0 polyglactin sutures or 2-0 polydiaxanone sutures.

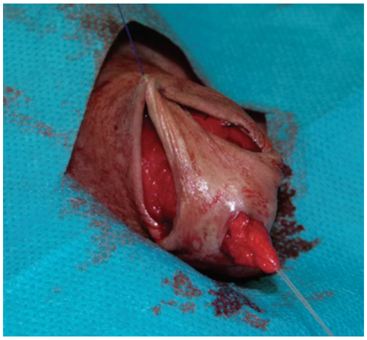

Figure 11.18 A buttonhole is made in the ventral skin flap and the urethra is brought through. The urethra is spatulated dorsally and sutured to the penile skin.

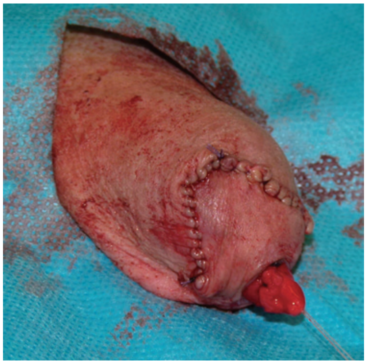

Figure 11.19 The penile shaft skin is sutured using 4-0 polyglactin continuous suture. A catheter is inserted.

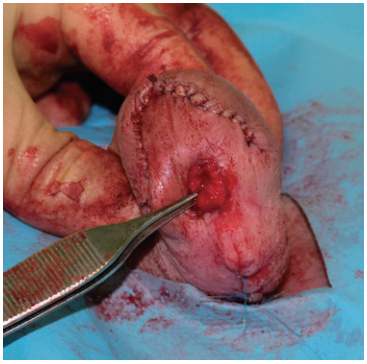

Figure 11.20 Final appearance of the urethral meatus.

Partial penectomy with urethral centralization

An alternative technique that aims to centralize the urethral meatus and to graft the neoglans is described below. Provided that the urethral stump is long enough to cover the corpora, this technique allows for a cosmetically superior result and reduces the risk of neomeatal stenosis (Figures 11.21, 11.22, 11.23 and 11.24).

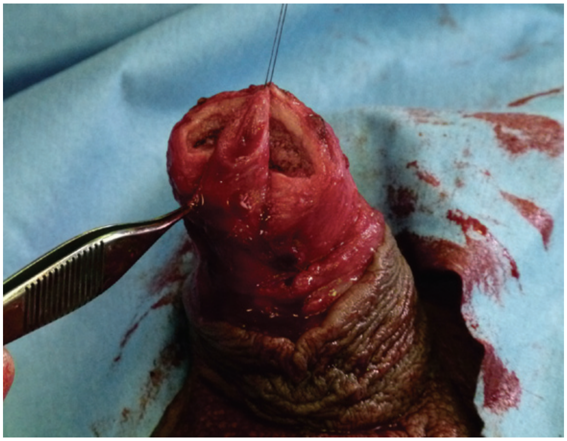

Figure 11.21 Once the corpora and urethra are transected, the urethra is partially mobilized off the tunica albuginea. The cavernosal arteries are cauterized or if possible ligated individually.

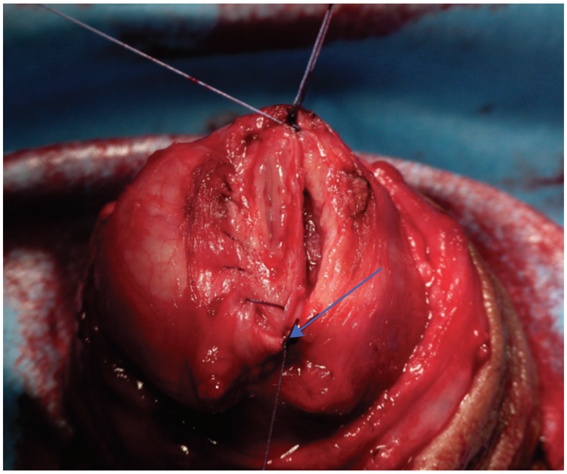

Figure 11.22 The urethra is sutured at the 12 o’clock position directly to the tunica albuginea. The tunica albuginea from each corpora are sutured together at the 6 o’clock position (blue arrow). Rather than oversewing the transected corpus cavernosum, the urethra is everted to cover the corpus cavernosum tips and form a neoglans.

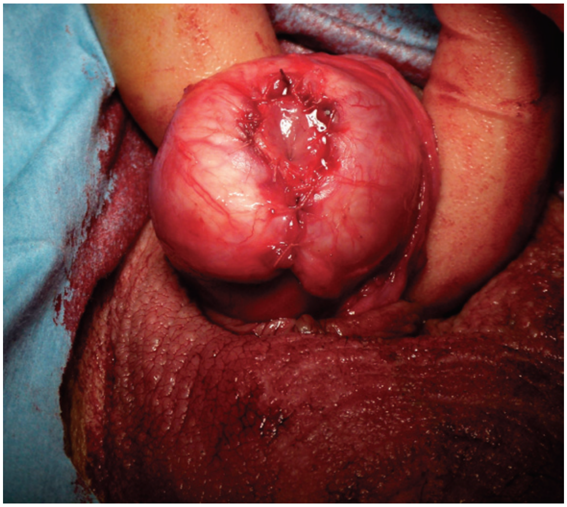

Figure 11.23 This allows the urethra to be centralized. The stump is covered by suturing Buck's fascia over the stump.

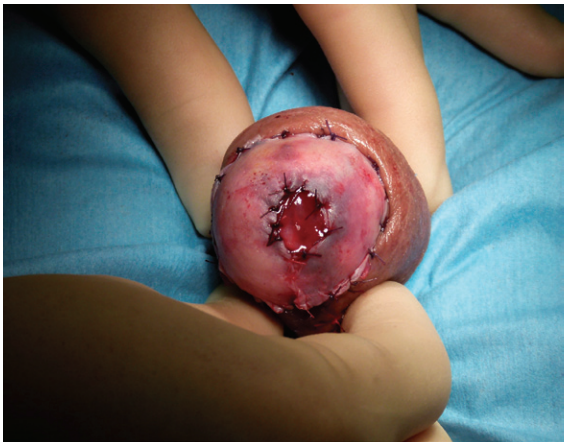

Figure 11.24 The neoglans is covered with a split thickness skin graft. Dressings are applied as for the glansectomy procedure and a catheter is inserted.

Total penectomy

Clinical features

For advanced penile tumors with proximal involvement of the corpora cavernosa, a total penectomy and perineal urethrostomy is required. Phallic reconstruction (see Chapter 12) at a later date using a radial artery free flap is aided by preserving the proximal crura which are used to house the rear tips of a penile prosthesis (Figures 11.25, 11.26, 11.27, 11.28 and 11.29).

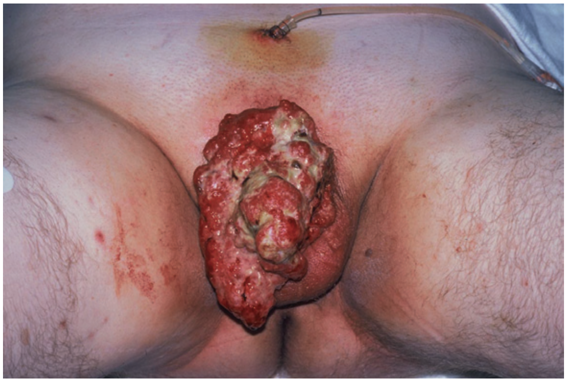

Figure 11.25 Extensive penile tumor involving the infrapubic area and scrotal wall.

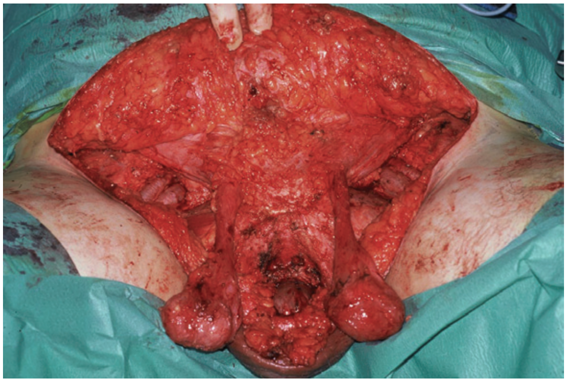

Figure 11.26 The penis is mobilized together with the suprapubic fat pad and scrotum. In this case bilateral inguinal lymphadenectomy is performed en bloc. The dorsal neurovascular bundle is ligated and the suspensory ligament is divided. The testicles and spermatic cord are preserved. (Source: Muneer, A, Arya M, Horenblas S. Textbook of Penile Cancer. Reproduced with kind permission of Springer Science+Business Media.)

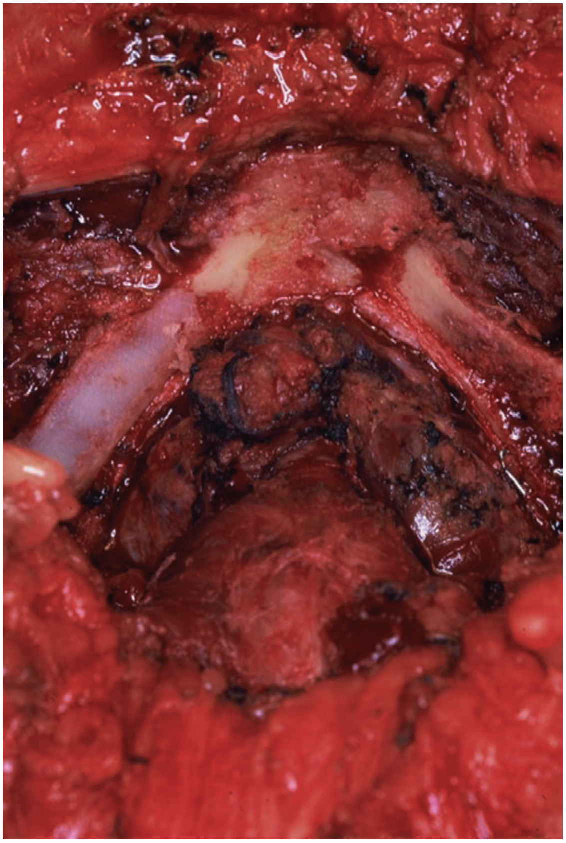

Figure 11.27 The proximal crura are dissected off the pubic bones. In this case the part of the pubic bone has been removed in order to remove the corpora.

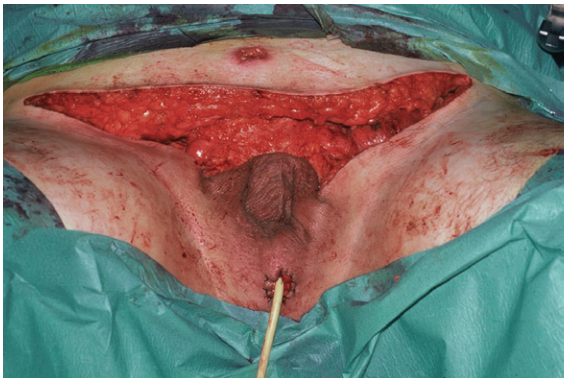

Figure 11.28 A perineal urethrostomy is created. The urethra can be spatulated on the ventral aspect and a flap of skin is brought in and sutured to the spatulated urethra. A catheter is inserted for 10 days.

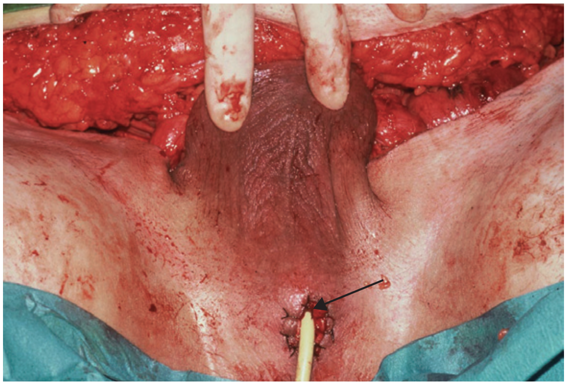

Figure 11.29 The perineal urethrostomy (black arrow) can be fashioned as a “rose bud” similar to an ileostomy which reduces the risk of stenosis.

Advanced penile tumors (T3/T4 lesions)

Clinical features

Advanced penile tumors have to be removed together with the surrounding soft tissue. This often leaves a large defect that has to be closed using a skin flap from the adjacent tissues (Figures 11.30 and 11.31).

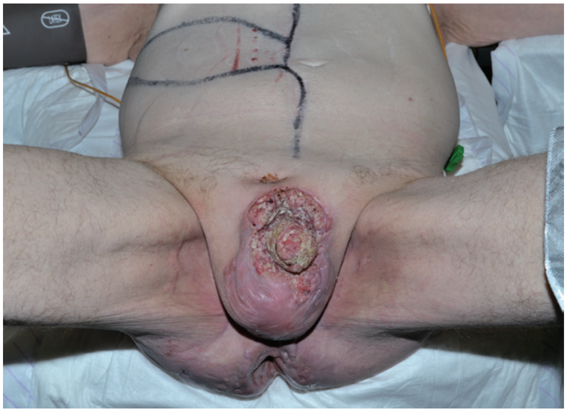

Figure 11.30 Large penile mass with bilateral mobile lymph node metastases, stage T3N2M0. Following surgical resection of the primary tumor and bilateral ilioinguinal lymphadenectomy procedures a large defect will result. A transverse rectus abdominis musculocutaneous (TRAM) flap has been marked. (Source: Muneer, A, Arya M, Horenblas S. Textbook of Penile Cancer. Reproduced with kind permission of Springer Science+Business Media.)

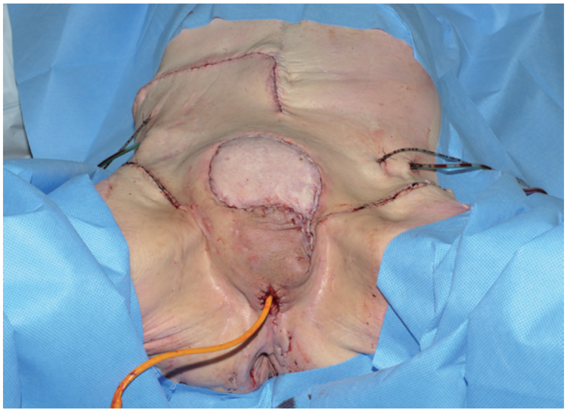

Figure 11.31 Primary closure of the inguinal incisions has been performed. The rectus abdominis muscle has been mobilized on the inferior epigastric pedicle and rotated in order to cover the defect resulting from the primary tumor. (Source: Muneer, A, Arya M, Horenblas S. Textbook of Penile Cancer. Reproduced with kind permission of Springer Science+Business Media.)

Management of inguinal lymph nodes

The primary draining lymph nodes are within the inguinal lymphatic system. The lymphatic drainage from the primary penile cancer is to both inguinal regions. The presence of metastatic disease within the inguinal lymph nodes is the single most important prognostic factor. Due to the low sensitivity of imaging modalities to detect cN0 disease, the management of these patients has been the subject of debate. As 20–25% of patients with cN0 disease have occult metastasis, the options for cN0 patients include close surveillance, dynamic sentinel lymph node biopsy or inguinal lymphadenectomy.

Dynamic sentinel lymph node biopsy procedure

The sentinel node procedure aims to identify microscopic lymph node invasion in the inguinal lymph nodes in patients presenting with clinically node negative groins (cN0 disease). In the absence of metastatic involvement in the sentinel node the inguinal region is considered to be tumor free. The sentinel node is identified before surgery with the help of a radioactive tracer ^{99m}Tc nanocolloid injected just proximal to the tumor and visualized by a single photon emission computerized tomography (SPECT-CT) scan. After identification on dynamic and delayed static imaging, the sentinel node is harvested at surgery with the aid of a hand-held gamma detector. Patent blue dye is also injected around the tumor or circumferentially just proximal to where the primary tumor was located. Patent blue is transported by lymphatic vessels to the lymph nodes (Figures 11.32, 11.33, 11.34 and 11.35).

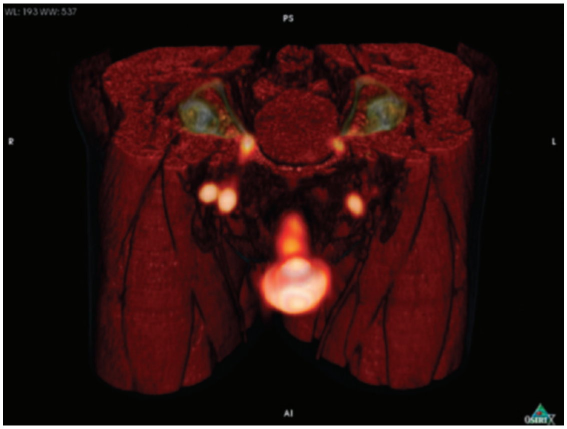

Figure 11.32 Example of a single photon emission computerized tomography (SPECT-CT) scan showing two sentinel nodes on the right side and one sentinel node on the left side. The other "hot" nodes are second echelon nodes. (Source: Muneer, A, Arya M, Horenblas S. Textbook of Penile Cancer. Reproduced with kind permission of Springer Science+Business Media.)

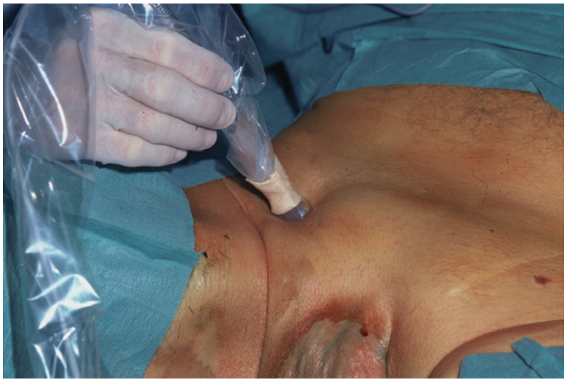

Figure 11.34 Following the ^{99m}Tc injection (dose between 20 and 40 MBq, volume 0.4 mL) the location of the sentinel node is marked on the skin by the nuclear medicine physician during SPECT-CT scanning. With the help of the hand-held gamma detector the location of the sentinel node is identified.

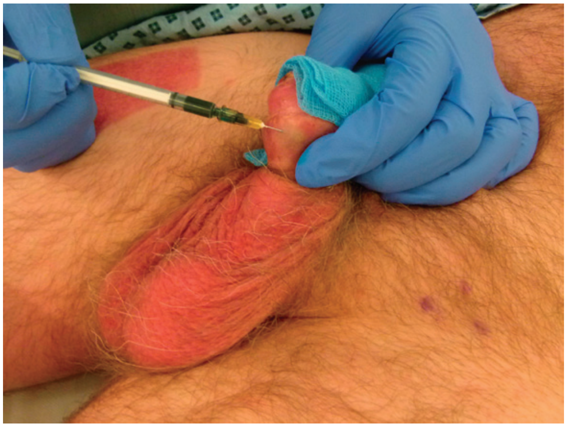

Figure 11.33 Patent blue dye is injected around the tumor.

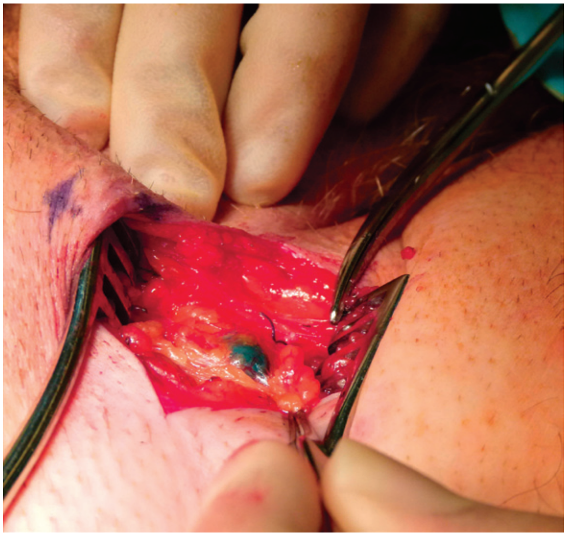

Figure 11.35 A small incision is performed parallel to the inguinal crease and over the sentinel node. Scarpa's fascia is identified and incised. Blue lymphatic vessels can be seen adjacent to the blue colored and "hot" lymph node. The sentinel node is excised ensuring that the lymphatic vessels are ligated to reduce the incidence of seroma. The bed of the sentinel node is rechecked with the hand-held gamma probe to ensure no further radioisotope is detected. The wound is closed in two layers.

Inguinal lymph node dissection

Clinical features

Radical inguinal lymphadenectomy is the preferred treatment for patients with palpable inguinal metastases that are not fixed to the surrounding structures. The anatomic boundaries are: proximally, the inguinal ligament; distally, the entrance to Hunter's canal, where the Sartorius muscle joins the adductor longus muscle; laterally, the Sartorius muscle; and medially, the adductor longus muscle. Laterally a 15-cm perpendicular line from the anterior superior iliac spine together with a 20-cm perpendicular line from the pubic tubercle marks the quadrangular area of lymphatic tissue that must be excised.

Surgical management

A variety of incisions can be performed although remaining parallel to the inguinal crease either 1 cm suprainguinal or infrainguinal is associated with fewer complications. If the lymph nodes are fixed to the overlying skin then an ellipse of skin is also excised. The operation can also be performed with the same anatomic boundaries using laparoscopic or robot-assisted techniques provided that the lymph nodes are not fixed to adjacent structures (Figure 11.36).

Patient preparation

Patients are positioned supine and the lower limb is abducted. Broad spectrum preoperative antibiotics are administered (Figure 11.37).

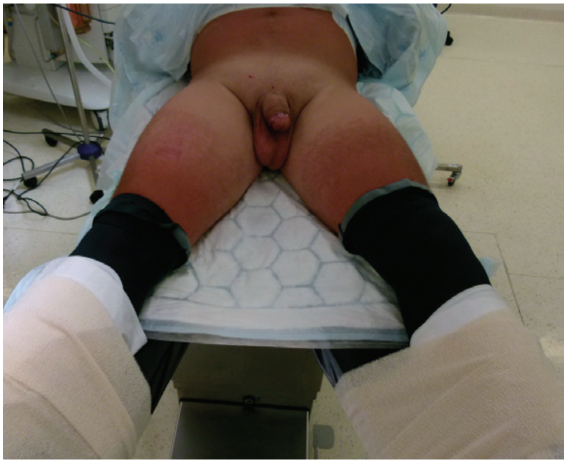

Figure 11.36 Patient positioned with lower limbs abducted.

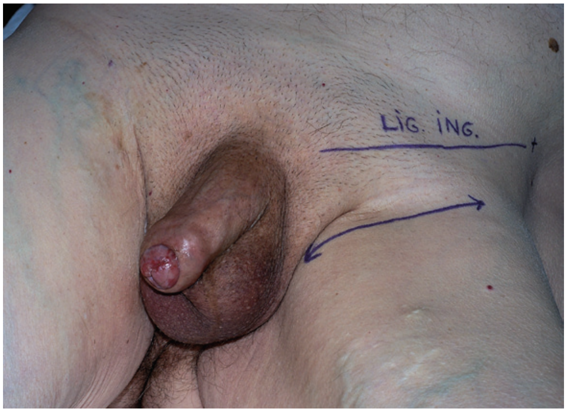

Figure 11.37 The inguinal ligament has been marked. The incision is located below the inguinal crease. (Source: Muneer, A, Arya M, Horenblas S. Textbook of Penile Cancer. Reproduced with kind permission of Springer Science+Business Media.)

Radical inguinal lymphadenectomy

Palpable inguinal lymph nodes that persist despite a course of antibiotics are invariably metastatic and a radical inguinal lymphadenectomy is required (Figures 11.38, 11.39, 11.40, 11.41, 11.42 and 11.43). In impalpable cN0 disease the risk of metastatic disease is up to 20%. In centers where dynamic sentinel lymph node biopsy cannot be performed, an alternative option is to perform a superficial modified inguinal lymphadenectomy and use an on table frozen section to identify any lymph node involvement.

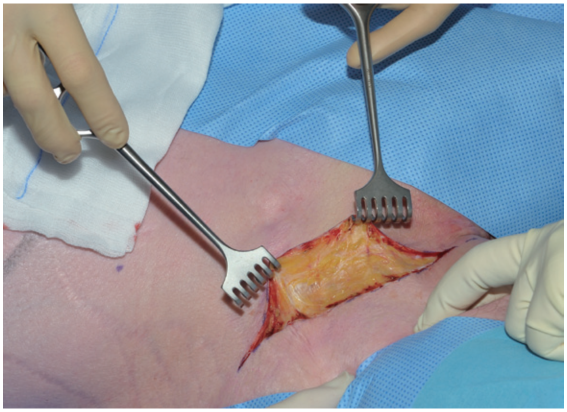

Figure 11.38 A subinguinal skin incision is performed. The wound is deepened until the clear subcutaneous fascia becomes visible. This is Scarpa's fascia in the region of the inguinal crease and is continuous with Camper's fascia into the thigh.

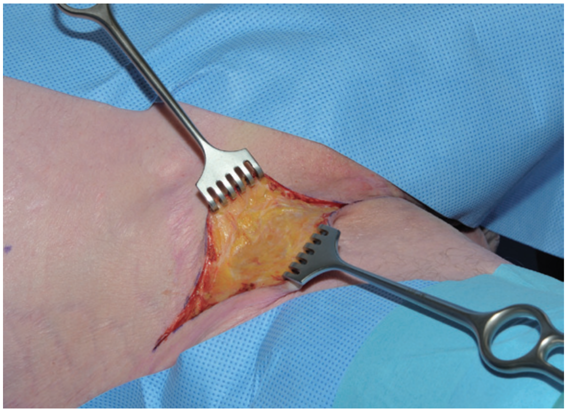

Figure 11.39 This fascia is distinguished from the other fascial layers present before the skin flaps are developed.

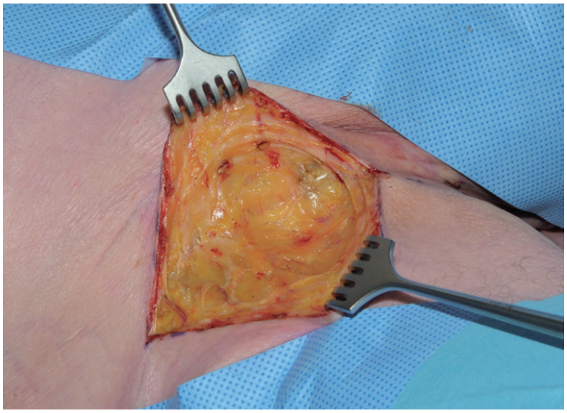

Figure 11.40 The skin flaps are elevated ensuring that the subcutaneous tissue and fascial layer is intact. The external oblique aponeurosis is identified superiorly and the saphenous vein is isolated. The lymphatic tissue is excised using blunt and sharp dissection starting laterally and dissecting medially ensuring that the fascia lata remains intact.

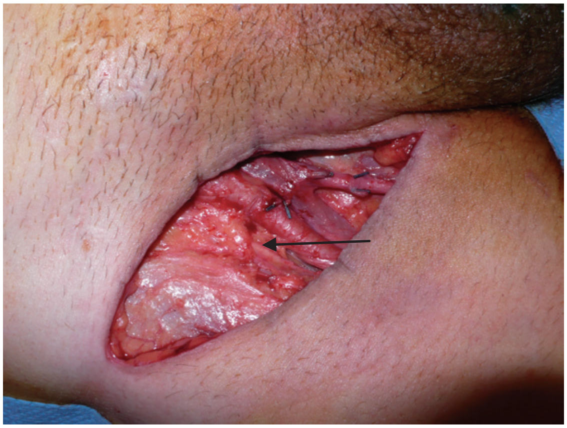

Figure 11.41 Lymphatic vessels are meticulously ligated throughout the dissection. If possible the saphenous vein is preserved. The femoral artery (black arrow) and femoral vein are skeletonized ensuring that all lymphatic tissue is removed. (Source: Muneer, A, Arya M, Horenblas S. Textbook of Penile Cancer. Reproduced with kind permission of Springer Science+Business Media.)

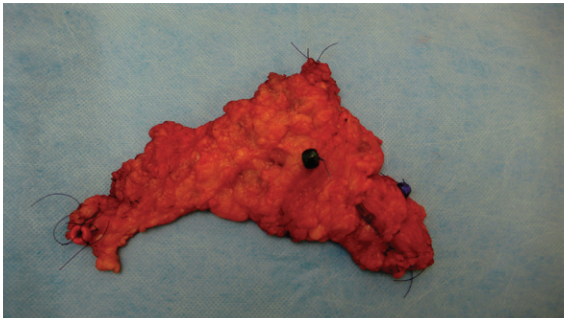

Figure 11.42 Lymphatic tissue excised. For orientation colored beads have been used.

Postoperative care

A catheter is inserted and patients remain on bed rest for 24 hours with the hip flexed in order to reduce the tension on the skin flaps. The drain remains *in situ* until the lymph drainage reduces to less than 40 mL/day.

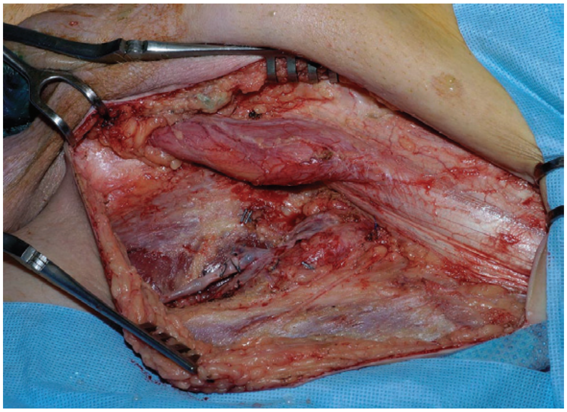

Figure 11.43 The anatomic boundaries after node dissection: proximally, the inguinal ligament; distally, Hunter's canal (crossing of sartorius muscle and adductor longus muscle); medially, adductor longus muscle; dorsally, femoral artery and vein. The saphenous vein was spared in this patient and covered by the transposed proximal sartorius muscle. In high risk patients, for whom adjuvant radiotherapy is considered to be necessary, protection of the skin, femoral artery and vein can be given by performing a sartorius flap. The origin of the muscle at the anterior superior iliac spine is detached and the muscle is rotated medially to cover the femoral blood vessels. The sartorius muscle is sutured to the inguinal ligament using 2-0 PDS interrupted sutures. (Source: Muneer, A, Arya M, Horenblas S. Textbook of Penile Cancer. Reproduced with kind permission of Springer Science+Business Media.)

Superficial modified inguinal lymphadenectomy

Clinical features

Patients presenting with impalpable disease in the inguinal regions can also be offered a superficial modified inguinal lymphadenectomy. The extent of the dissection is smaller than for a radical inguinal lymphadenectomy (Figures 11.44, 11.45, 11.46 and 11.47).

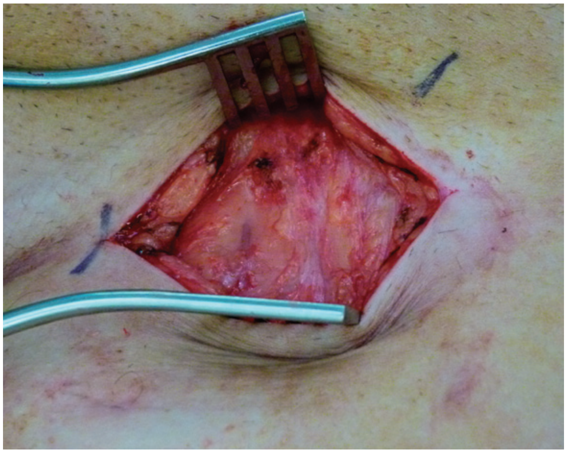

Figure 11.44 A subinguinal incision is performed from the adductor longus tendon to just lateral to the femoral artery. The wound is deepened and a “false” fascial layer is initially encountered before the shiny Scarpa’s fascia is identified.

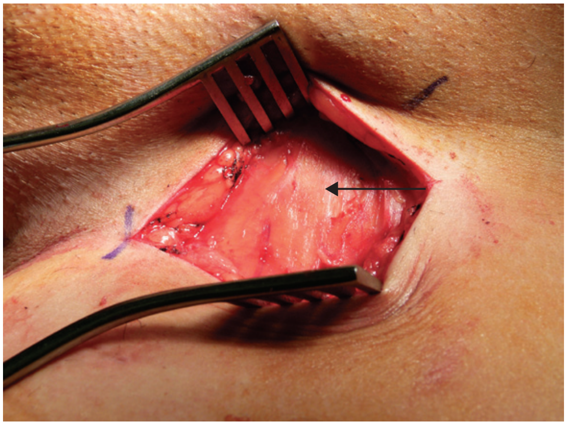

Figure 11.45 Scarpa’s fascia (black arrow) is identified before it is incised. This distinct fascial layer is an important landmark that ensures that the skin flaps are raised with the subcutaneous tissue intact.

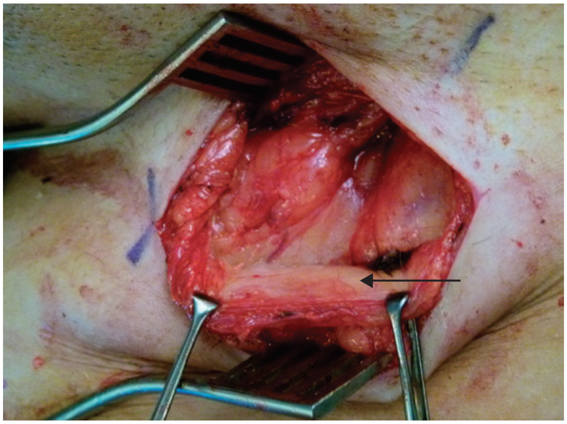

Figure 11.46 The skin flaps are developed (black arrow) and the underlying lymphatic tissue is exposed. The lymphatic tissue is excised starting adjacent to the femoral artery. Lymphatic channels are ligated in order to reduce the risk of postoperative seroma and lymph fistula.

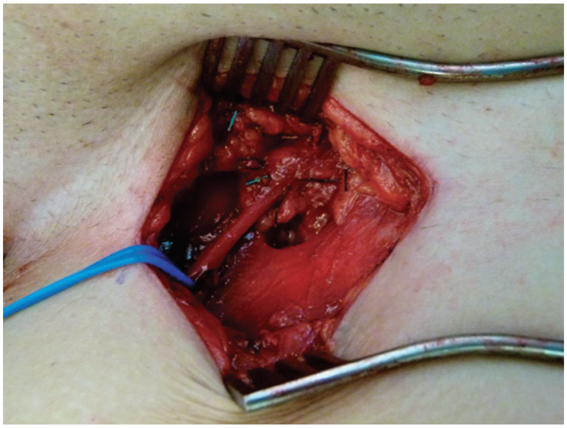

Figure 11.47 The dissection should continue to the level of the inguinal ligament. Lymphatic tissue overlying the femoral vein and fossa ovalis is also excised. The saphenous vein is preserved (blue loop). A suction drain is inserted before a layered closure is performed. Interrupted 2-0 absorbable polyglactin sutures are used to close the fascial layer. Accurate approximation of the skin edges ensures that the risk of wound dehiscence is reduced.

Ilioinguinal and pelvic node dissection

Clinical features

A combined inguinal and pelvic node dissection, ilioinguinal dissection, is usually performed using separate incisions. Pelvic node dissections are reserved for obvious lymphadenopathy within the pelvis or when there are two or more metastatic inguinal lymph nodes on the same side. It is also performed when then there is a single metastatic lymph node with extracapsular spread. The most commonly used incision for the pelvic node dissection is a midline lower abdominal incision although the procedure can also be performed using laparoscopic or robot-assisted techniques. The boundaries for the lymph node dissection are: cranially, the aortic bifurcation; and distally, the passage to the inguinal canal. A node located medial to the femoral vein can almost always be found there and has traditionally been called Cloquet's node or the node of Rosenmüller. The medial boundary is formed by the branches of the internal iliac artery, the bladder and the prostate.

The lateral boundary is the genitofemoral nerve. These boundaries are no different from an extended node dissection for bladder or prostate cancer (Figures 11.48 and 11.49).

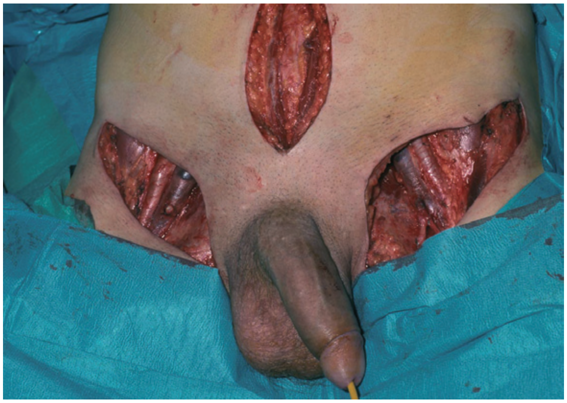

Figure 11.48 Bilateral radical inguinal lymphadenectomies have been performed. A midline incision is used to perform bilateral pelvic lymph node dissections. (Source: Muneer, A, Arya M, Horenblas S. Textbook of Penile Cancer. Reproduced with kind permission of Springer Science+Business Media.)

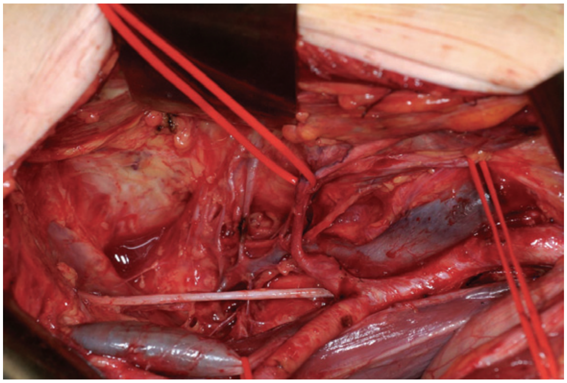

Figure 11.49 A pelvic lymph node dissection has been performed. The boundaries can be seen: cranially, the aortic bifurcation; medially, all the branches of the internal iliac artery, the bladder and the prostate; laterally, the genitofemoral nerve. (Source: Muneer, A, Arya M, Horenblas S. Textbook of Penile Cancer. Reproduced with kind permission of Springer Science+Business Media.)

12

Penile and Scrotal Reconstruction

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Additional contribution from Peter R. Malone[3]

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Introduction

Reconstructive surgery of the penis has continued to develop over recent years. However, reconstructing the penis still remains a significant challenge anatomically, functionally and aesthetically.

The primary goal of penile reconstructive surgery is to achieve a cosmetically acceptable result with restoration of the ability to void, while standing, from the tip of the phallus and to engage in penetrative sexual intercourse with erogenous sensation.

Clinical features

Traumatic injuries and surgery for penile cancer can result in the penis losing varying degrees of length and function. Benign lesions such as lichen sclerosus limited to the glans penis are amenable to local excision without a significant loss in function.

In cases of penile trauma, partial or complete avulsion requires an immediate surgical repair with preservation of as much viable tissue as possible. In fact, no other tissue in the body has characteristics, in terms of elasticity, texture and color, to be considered an ideal candidate for genital reconstruction. When primary repair with genital tissue is not feasible, skin grafts with a variety of pedicled and free flaps, are available for genital reconstruction.

Assessment

Before undertaking reconstructive surgery, the preoperative erectile function and stretched penile length is documented. For penile lesions that are suspected to be premalignant or malignant, a biopsy of the lesion is required in order to assess the depth of invasion and decide on the extent of the surgical excision required.

The patients' expectations have to be realistic. The aim of reconstructive surgery is primarily to restore voiding and sexual function and provide a cosmetically acceptable phallus. In cases where patients require a free flap, a vascular assessment of the donor vessels is performed (e.g. Allen's test) followed by a duplex ultrasound of the radial and ulnar artery when a forearm free flap is being considered. Patients who have already been surgically treated for penile cancer often have undergone inguinal lymph node dissections and may have had the saphenous vein sacrificed which is normally used for the venous anastomosis for a free flap. Therefore careful planning is required in case these situations arise.

Surgical management

The aim of surgery is to remove any underlying pathology and restore the penile anatomy. For lesions that are limited to the glans penis or distal penile shaft skin, excision followed by grafting using a split thickness skin graft

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(STSG) provides a cosmetically and functionally acceptable result. In situations where the penile shaft skin has to be excised and replaced with a skin graft, a full thickness skin graft (FTSG) is preferred due to the ability of an FTSG to maintain elasticity and limit the amount of contraction. More extensive amputations or congenital disorders of the penis require reconstruction using either a pedicled or free flap.

Surgical risks

The use of skin grafts is associated with donor site morbidity (e.g. wound infection, scarring). Once placed on the recipient area, both STSG and FTSG are at risk of graft failure and contracture. In cases of graft failure, provided that the bed is allowed to granulate, a further skin graft can be utilized. Free flaps require a microvascular arterial and venous anastomosis which are subject to vascular thrombosis resulting in flap loss. Provided that the vascular thrombosis is recognized early, revision of the anastomosis often salvages the flap.

Surgical outcomes

Reconstructive procedures limited to the glans and penile shaft on the whole do not interfere with erectile function and have an acceptable cosmetic outcome. Where there has been a significant loss of the corpus cavernosum, phallic reconstruction is associated with a higher complication rate related to strictures of the neourethra and also infection of the penile prosthesis. Glans reconstruction following glansectomy or glansectomy combined with distal corporectomy is relatively straightforward. Complications include poor graft take requiring regrafting in around 6% of patients and an inadequate final cosmetic or functional outcome in 1% of cases. Overall, almost all patients retain sexual and urinary function and are reported to be engaging in satisfactory penetrative sex 3 months postoperatively.

Patient preparation

For procedures limited to the glans penis, the patient is positioned supine under general anesthetic. Exposure of the donor sites for an STSG or FTSG is required. The STSG is commonly harvested from the thigh or outer arm. A FTSG is harvested from the axilla, inguinal region or arm. These areas should be shaved and prepared at the start of the procedure.

Radial artery forearm flaps are raised from the nondominant forearm and requires exposure and epilation prior to surgery. In these cases FTSG are harvested from the buttocks to cover the skin defect on the forearm.

Meatoplasty

Contribution from Peter R. Malone

Lichen sclerosus et atrophicus or balanitis xerotica obliterans is a chronic scleroatrophic inflammatory process affecting the glans and prepuce. In more advanced cases the external urethral meatus and anterior urethra are also involved. Meatal stenosis without involvement of the navicular fossa is invariably due to lichen sclerosus and results in impairment of the flow of urine as well as spraying of urine. Although this can be initially managed by performing a meatal dilatation, recurrent stenosis is often corrected by performing a ventral meatotomy. However, a ventral meatotomy can result in unsightly puckering of the glans. A modified meatoplasty technique is described which provides a better functional and cosmetic outcome (Figures 12.1, 12.2, 12.3, 12.4, 12.5, 12.6, 12.7, 12.8, 12.9, 12.10, 12.11, 12.12, 12.13 and 12.14).

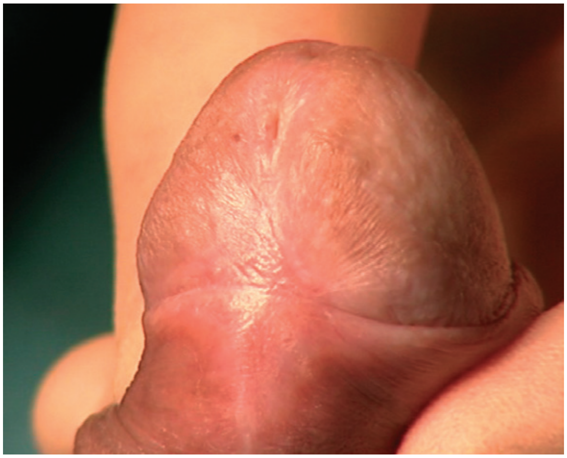

Figure 12.1 A ventrally sited (retrusive) meatus in a patient with lichen sclerosus.

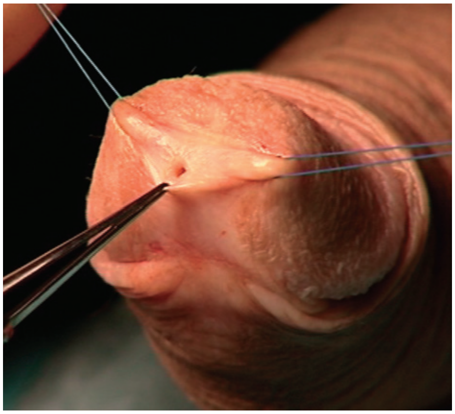

Figure 12.2 Two stay sutures are placed on either side of the meatus. The lichen sclerosus and meatal stenosis is clearly demonstrated.

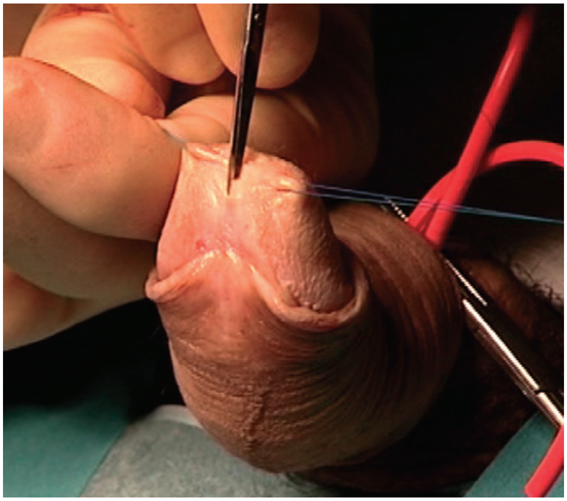

Figure 12.3 A small ventral meatotomy is performed using fine straight scissors.

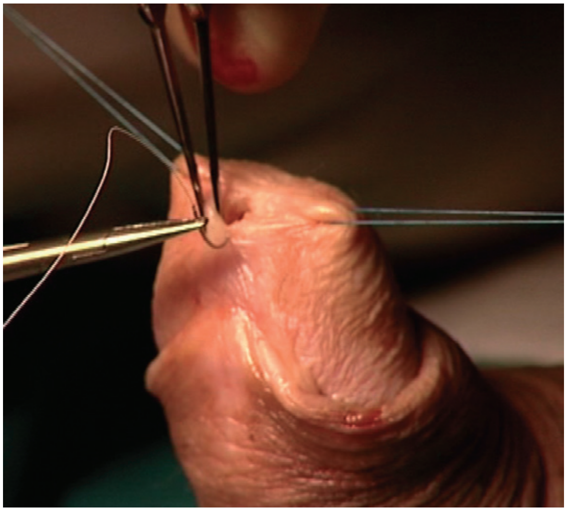

Figure 12.4 The glans and urethral epithelia are apposed using three 5-0 polyglactin sutures.

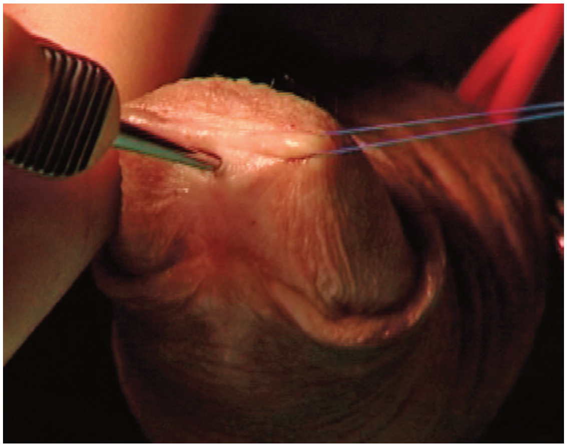

Figure 12.5 Forceps are inserted through the meatus in order to ensure that the navicular fossa is uninvolved.

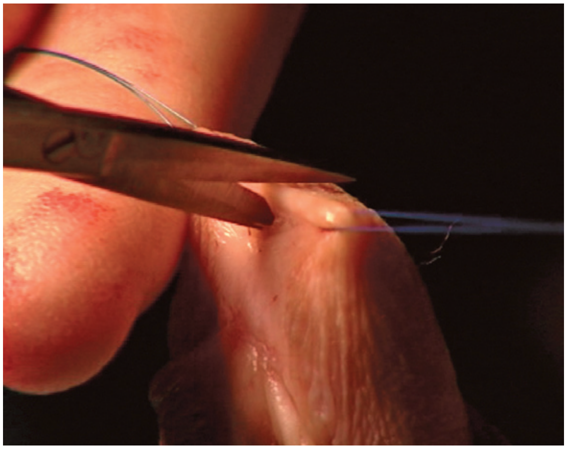

Figure 12.6 A deeper dorsal meatotomy is performed to open the meatus.

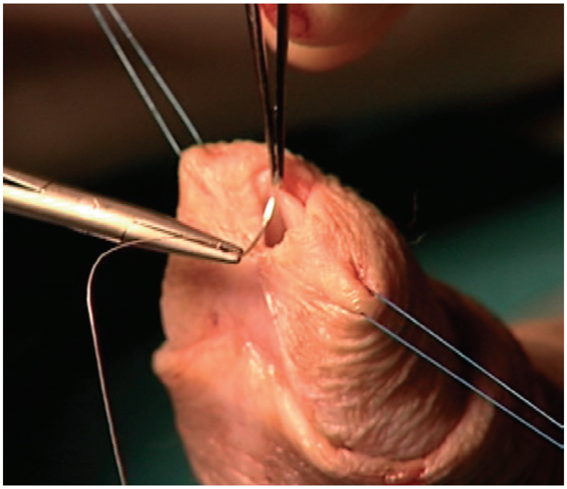

Figure 12.7 Again the urethral and glans epithelia are apposed with five fine polyglactin sutures.

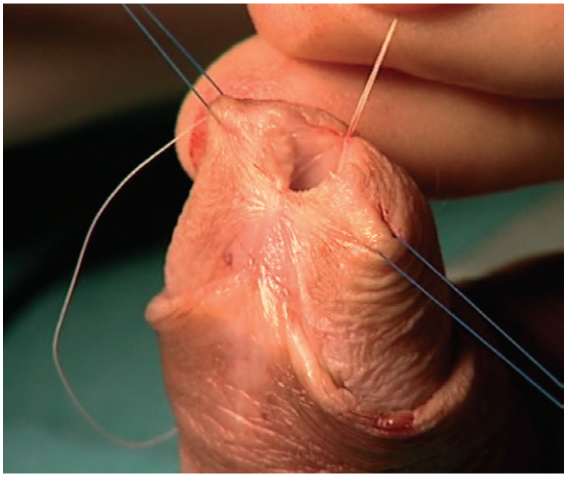

Figure 12.8 The first suture has been tied resulting in a wide-open meatus with perfect apposition of the epithelia to promote healing by primary intention.

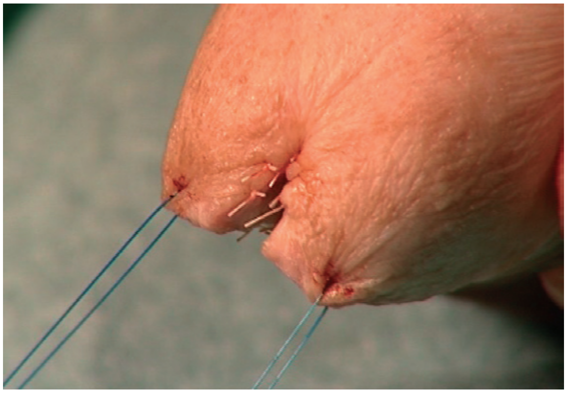

Figure 12.9 This produces a puckered “kippered” penis because of the thickness of the spongiosum. If left like this it would be unsightly and results in spraying of urine. Therefore further steps are performed to overcome this.

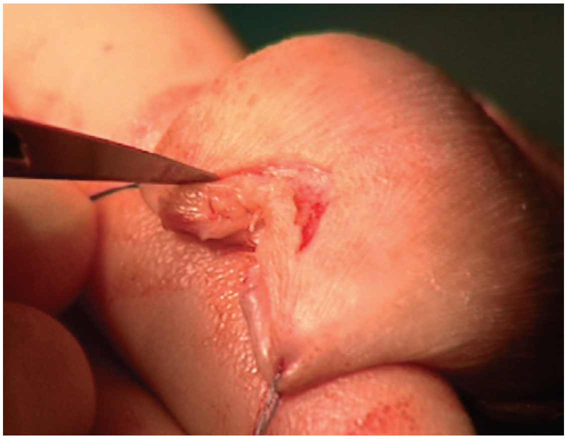

Figure 12.10 An inverted V-shaped "relieving" incision is performed which produces inner and outer cut edges, left and right.

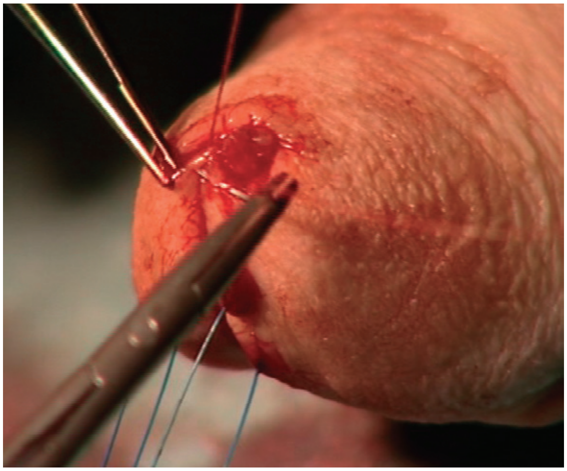

Figure 12.11 The inner edges are apposed using a continuous 5-0 polyglactin suture to form the roof of the distal neourethra.

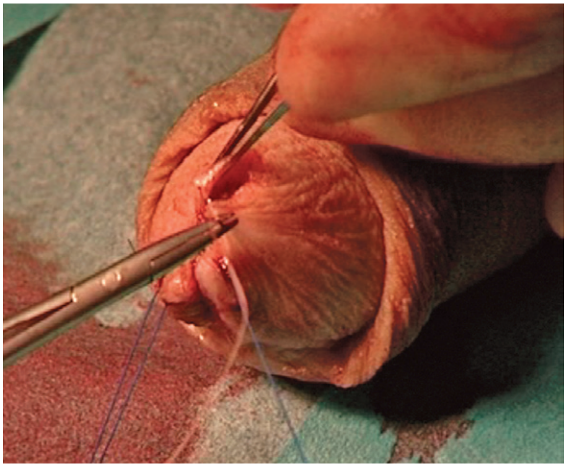

Figure 12.12 The outer edges are then apposed using interrupted sutures. Sometimes a mattress suture gives better apposition.

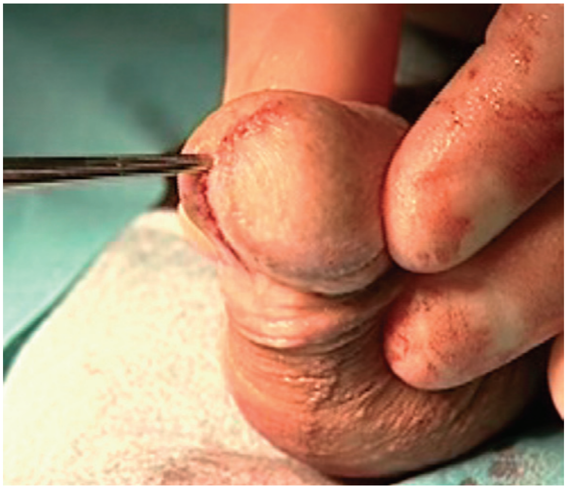

Figure 12.13 Once this has been completed, the shape of the glans is restored with a slit meatus of normal caliber.

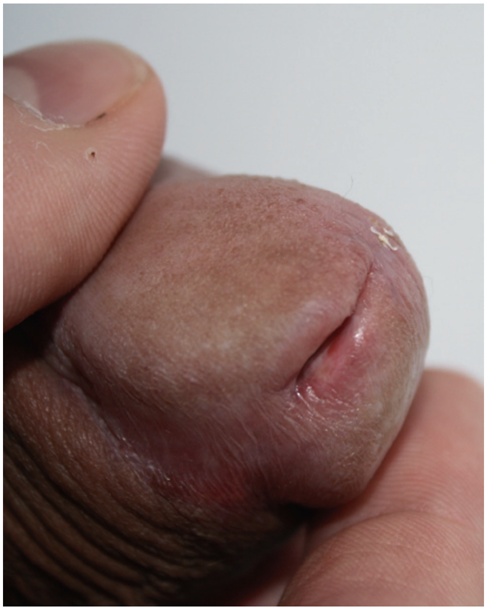

Figure 12.14 At 2 weeks postoperative follow-up, the meatus can be seen to be wide open. Some of the sutures have yet to absorb in this figure.

Glans reconstruction

Reconstruction of the glans in isolation is required following traumatic amputation or surgery for benign and malignant conditions. Surgical excision may be limited to the glans epithelium or in malignant cases the entire glans penis is excised.

Glans resurfacing is a surgical procedure that is performed in patients with lichen sclerosus or carcinoma *in situ* of the glans penis that has failed medical therapy. The procedure involves the partial or complete excision of the glans mucosa and subepithelial tissue followed by reconstruction using a STSG of nongenital skin [1].

Total glans resurfacing

See Figures 12.15, 12.16, 12.17 and 12.18.

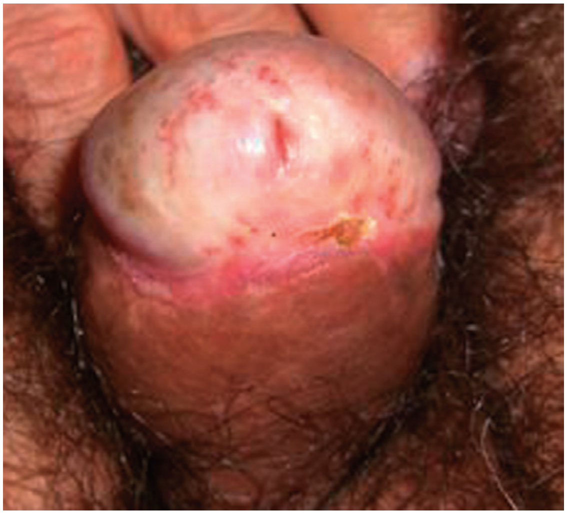

Figure 12.15 Extensive lichen sclerosus of the glans penis and meatus resulting in meatal stenosis. (Source: Garaffa G, Shabbir M, Christopher N, Minhas S, Ralph DJ. J Sex Med 2011; 8: 1246–53. Reproduced with permission of John Wiley & Sons Ltd.)

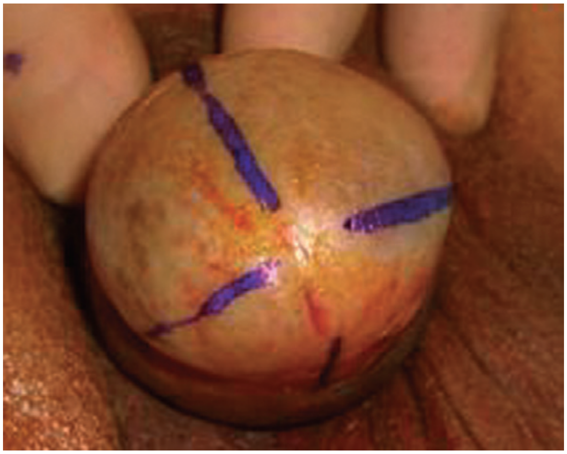

Figure 12.16 The glans penis is marked in quadrants from the urethral meatus to the coronal sulcus. The glans mucosa and subepithelium is dissected off the underlying corpus spongiosum using tenotomy scissors or a No 15 scalpel. (Source: Garaffa G, Shabbir M, Christopher N, Minhas S, Ralph DJ. J Sex Med 2011; 8: 1246–53. Reproduced with permission of John Wiley & Sons Ltd.)

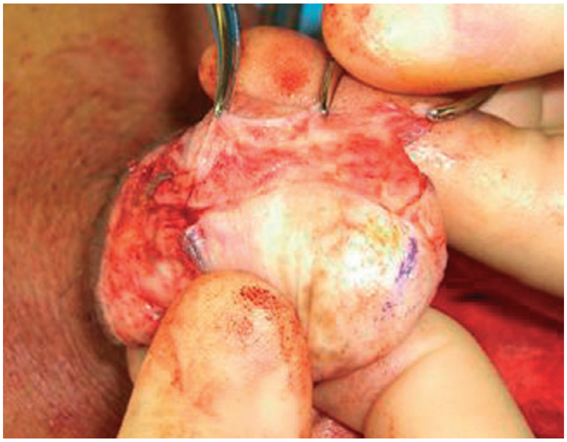

Figure 12.17 The glans and the coronal sulcus are completely denuded. Each quadrant that is excised is sent separately for histological analysis. In premalignant disease of the glans penis separate deeper biopsies of the corpus spongiosum are performed and sent for histologic analysis. (Source: Garaffa G, Shabbir M, Christopher N, Minhas S, Ralph DJ. J Sex Med 2011; 8: 1246–53. Reproduced with permission of John Wiley & Sons Ltd.)

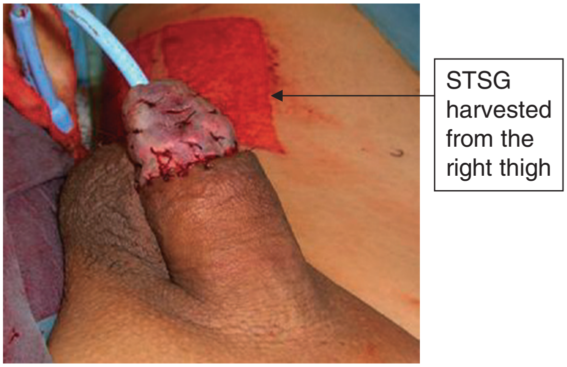

Figure 12.18 The denuded glans and corona are covered with a split thickness skin graft (STSG) of nongenital skin. The graft is harvested using a dermatome with the graft thickness ranging 0.008–0.016 inch. The STSG is quilted using 5-0 or 6-0 absorbable polyglactin sutures. Further quilting at the level of the coronal sulcus recreates the coronal groove. (Source: Garaffa G, Shabbir M, Christopher N, Minhas S, Ralph DJ. J Sex Med 2011; 8: 1246–53. Reproduced with permission of John Wiley & Sons Ltd.)

Partial glans resurfacing

In certain situations the disease is limited to a small area on the glans penis. The aim of this procedure is to preserve as much of the normal glans mucosa as possible. This is particularly important around the coronal sulcus for erogenous sensation (Figures 12.19, 12.20, 12.21 and 12.22).

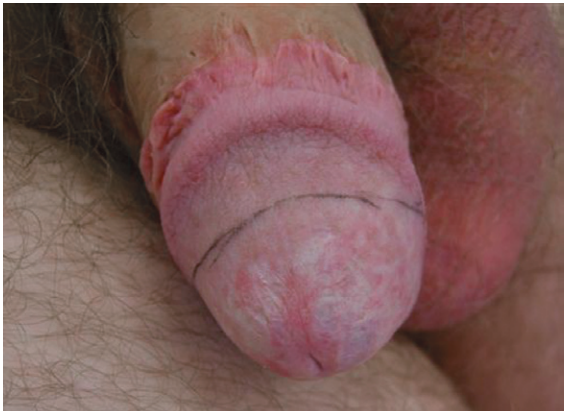

Figure 12.19 Lichen sclerosus limited to the distal glans penis which persists despite circumcision and topical corticosteroid treatment. (Source: Garaffa G, Shabbir M, Christopher N, Minhas S, Ralph DJ. J Sex Med 2011; 8: 1246–53. Reproduced with permission of John Wiley & Sons Ltd.)

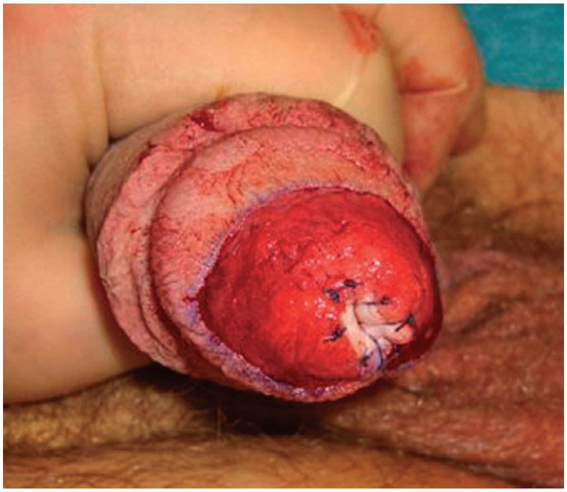

Figure 12.20 Glans epithelium and subepithelial tissue is excised using tenotomy scissors or alternatively a No 15 scalpel can be used as described above. The corpus spongiosum is exposed. Bleeding vessels can be coagulated or oversewn. However, the generalized bleeding from the denuded corpus spongiosum will only stop once a graft has been placed and quilted. (Source: Garaffa G, Shabbir M, Christopher N, Minhas S, Ralph DJ. J Sex Med 2011; 8: 1246–53. Reproduced with permission of John Wiley & Sons Ltd.)

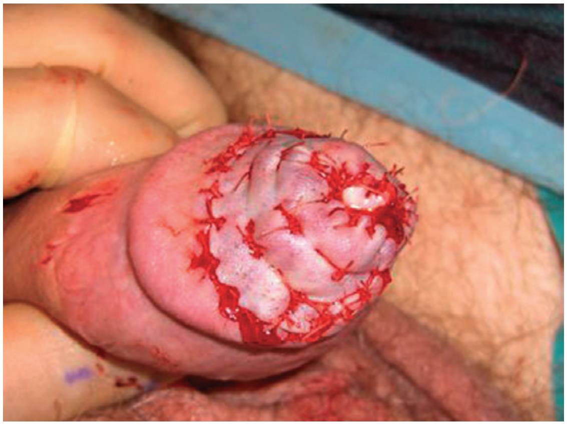

Figure 12.21 A STSG of nongenital skin is harvested and the edges are sutured proximally to the glans epithelium which was not excised and distally to the meatus. The STSG is then quilted on to the denuded glans penis using 5-0 and 6-0 absorbable sutures. A tie-over dressing can be used to ensure that the graft is immobilized. (Source: Garaffa G, Shabbir M, Christopher N, Minhas S, Ralph DJ. J Sex Med 2011; 8: 1246–53. Reproduced with permission of John Wiley & Sons Ltd.)

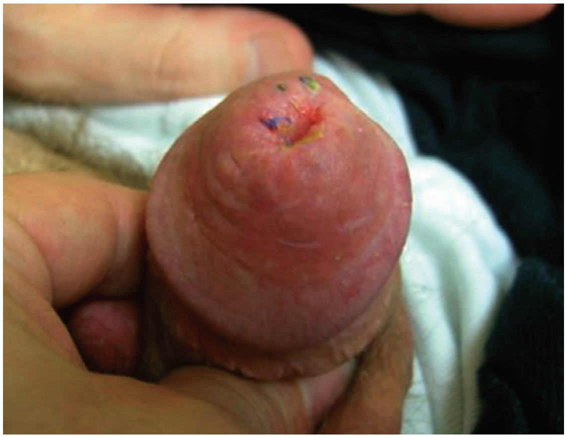

Figure 12.22 The final result 6 months postoperatively. (Source: Garaffa G, Shabbir M, Christopher N, Minhas S, Ralph DJ. J Sex Med 2011; 8: 1246–53. Reproduced with permission of John Wiley & Sons Ltd.)

Glansectomy

Glansectomy is indicated for widespread pT1 and pT2 squamous cell cancer of the glans penis. The procedure involves excising the glans penis followed by reconstruction of a neoglans using an STSG. The technique is described in Chapter 11 as the main indication is for patients diagnosed with penile cancer.

Scrotal reconstruction

Loss of scrotal skin can occur secondary to Fournier's gangrene, trauma or following excision of genital neoplasms. The laxity of the scrotal skin allows for primary closure even when there is extensive skin loss.

If primary closure is not possible then reconstruction of the scrotum can be achieved using a meshed STSG and local musculocutaneous or fasciocutaneous flaps. The repair of scrotal defects allows the testicles to maintain spermatogenesis in the normal anatomic position. Although subcutaneous thigh pouches have been used previously, the thermoregulation required for normal spermatogenesis is impaired. Therefore meshed STSG are an alternative solution for scrotal repair because they allow the drainage of exudate, thus improving the success of graft take to nearly 100%. Prior to grafting with a meshed STSG, the exposed tunica vaginalis and testicles are sutured together in order to minimize the surface area to be grafted and allow the formation of granulation tissue which forms the bed for the meshed graft. When healed, the graft will mimic the rugae normally present on the scrotum. However, patients undergoing scrotal reconstruction with STSG must be warned that graft contracture is inevitable and therefore the neoscrotum will feel tight and insensate. The technique is described in Chapter 14.

Local flaps are the preferred option for providing testicular coverage when there is extensive scrotal and perineal skin loss. The use of local flaps is not associated with the typical complications of skin grafts such as skin maceration, poor take and breakdown secondary to fecal and urinary contamination and requires less intense postoperative care.

Classically, the vertical rectus abdominis musculocutaneous flap yields the best cosmetic and functional results but is also associated with significant donor site morbidity. Other musculocutaneous and fasciocutaneous flaps based on tissue from the perineum, groin and lower limbs have been described. Among these, the medial circumflex femoral artery perforator flap, the gracilis musculofasciocutaneous flap, the neurovascular pedicled pudendal thigh flap and the Singapore flap (perineal artery flap) are the most commonly used.

Penile shaft reconstruction

Indications for penile shaft reconstruction are partial or subtotal penectomy, traumatic amputation of the penis, micropenis, penile agenesis and female-to-male transsexualism. Partial penile amputations are initially managed conservatively. With additional penile augmentation procedures described in Chapter 8, a sufficient gain in penile length may be achieved to allow penetrative intercourse and voiding while standing. If despite these procedures there is an inadequate gain in penile length, patients can be offered phallic reconstruction.

Phallic reconstruction should ideally address the following issues:

1 Create a competent neourethra to allow micturition in the standing position.

2 Reconstruct a phallus that has both tactile and erogenous sensitivity and is aesthetically acceptable to the patient.

3 Have enough bulk to allow the insertion of a penile prosthesis for penetrative intercourse.

4 It should be linked to minimal scarring and disfigurement with no functional loss in the donor area.

The choice of technique should be tailored to the patient's expectations, body habitus, previous surgical procedures and comorbidities. In particular, cardiovascular risk factors such as diabetes, hypertension, dyslipidemia, obesity and cigarette smoking are a relative contraindication to the use of free flaps because of the high risk of vascular complications. Moreover, in obese patients, some types of flaps are associated with a poor cosmetic result and previous abdominal surgery may be a contraindication to the use of infra-umbilical abdominal flaps.

Patients must be fully counseled about each type of phalloplasty and should have reasonable expectations. In particular, the surgeon has to assess whether the patient is concerned solely with cosmesis and urinary function or if he also wishes to have a sensate phallus and be able to engage in penetrative sexual intercourse.

The radial artery free flap phalloplasty (RAFF) was originally described by Song et al. in 1982 [2] and the successful outcomes in patients with penile amputation was published by Chang and Hwang in 1984[3]. The reconstructive procedure involves the creation of "a tube within a tube" using forearm skin with the urethra fashioned from the nonhair-bearing area. The whole flap is based on the radial artery. This technique allows the creation of a cosmetically acceptable phallus; sensation is maintained because of the coaptation of the antebrachial nerves to the dorsal nerve of the penis or to the iliohypogastric and ilioinguinal nerves.

Surgical risks

Complication rates of up to 45% can occur. Early complications are limited to the microsurgical vascular anastomoses which requires re-exploration and reanastomosis if the flap is compromised. Venous thrombosis occurs in 3% of cases at day 3 or 4 whereas arterial thrombosis occurs earlier. Later complications include meatal stenosis, urethral strictures, donor site morbidity and complications relating to the insertion of prosthetic material into the phallus to allow penetrative intercourse. The most common complications are neourethral strictures and fistulae, which occur in approximately 10% and 20% of cases, respectively. Surgical correction is almost always possible and, after revision surgery, 99% of patients are able to void standing up and from the tip of the phallus. Sensation on the phallus has been reported by 86% of patients with an overall satisfaction rate after revision surgery of 97%.

Penile prosthesis insertion in a phalloplasty is associated with a high risk of complications. This is due to the use of a Gore-Tex® or Dacron® sock that protects the cylinders from trauma and erosion in the absence of a natural tunica albuginea. In particular, infection rate, erosion rate and mechanical dysfunction of the device can be as high as 11.9%, 8.1% and 22.2%, respectively, with an overall revision rate of 41%.

Overall, after the completion of surgery, up to 60% of patients have a normally functioning penile prosthesis, are able to cycle the device and are therefore able to have penetrative sexual intercourse.

Radial artery based forearm free flap phalloplasty

This procedure involves three to four stages, which are usually carried out at 3-monthly intervals. The first stage creates a phallus followed by transposition to the recipient site. In the transsexual, an additional second stage involves the anastomosis of the native urethra to the phallic urethra. The third stage involves the sculpture of the glans and the insertion of a reservoir as part of a later three-piece inflatable penile prosthesis. In the female-to-male transsexual, during this stage, a testicular prosthesis is inserted into the labia majora on the same side as the reservoir. During the final stage, the cylinders and a pump of an inflatable penile prosthesis are inserted and connected with the reservoir. In the transsexual, the testicular prosthesis is removed and transferred to the contralateral labia and the penile prosthesis pump is inserted in the capsule that has formed around the testicular prosthesis (Figures 12.23, 12.24, 12.25, 12.26, 12.27 and 12.28).

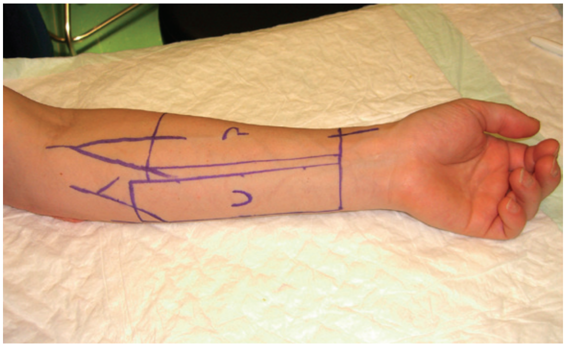

Figure 12.23 The course of the arteries and the width of the flap is marked. The flap is based on the radial artery, which is dissected to its origin from the brachial artery. The venous drainage is usually based on the cephalic vein, the venae comitantes of the radial artery and flap veins. The medial portion is relatively hairless and marked with a width of 4 cm and 15 cm long. This forms the neourethra. The lateral portion is usually 15 cm long and has a width of 14 cm at the base and of 11 cm at the tip and forms the phallus. (Source: Garaffa G, Raheem AA, Christopher NA, Ralph DJ. BJUI 2009; 104: 852–6. Reproduced with permission of John Wiley & Sons Ltd.)

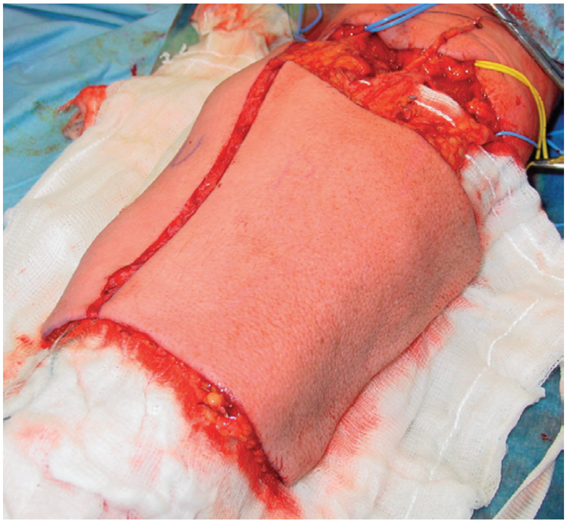

Figure 12.24 The flap is raised from the nondominant arm. A tourniquet is placed on the arm and inflated for a maximum of 2 hours. A small 1-cm strip of skin is de-epithelialized. (Source: Garaffa G, Christopher NA, Ralph DJ. Eur Urol 2010; 57: 715–22. Reproduced with permission of Elsevier.)

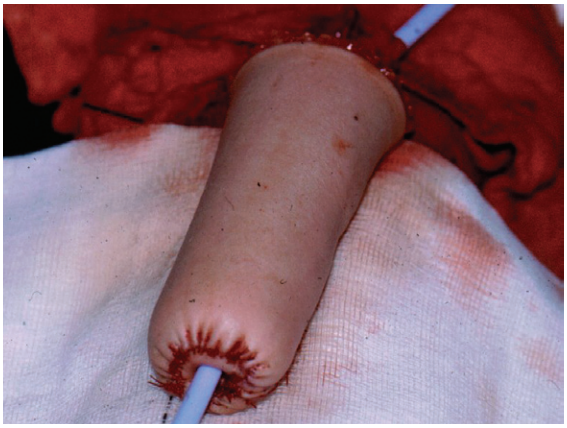

Figure 12.25 The flap is tubularized around a 16-Fr catheter according to the "tube within a tube" principle. The proximal portion is left spatulated for 2 cm in order to allow a primary anastomosis with the penile urethra, in the male, or to a labial flap, in the female-to-male transsexual. Once the neourethra has been completely fashioned, the lateral aspect of the flap is wrapped around the neourethra to form the bulk of the phallus. (Source: Garaffa G, Christopher NA, Ralph DJ. Eur Urol 2010; 57: 715–22. Reproduced with permission of Elsevier.)

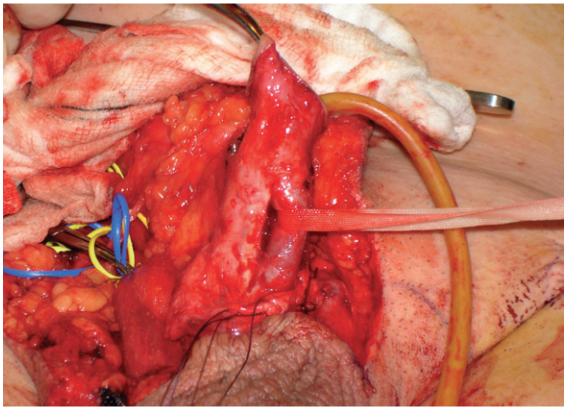

Figure 12.26 In patients who have undergone a previous penile amputation, the penile stump is preserved and the urethra is spatulated to be primarily anastomosed to the phallic neourethra. (Source: Garaffa G, Raheem AA, Christopher NA, Ralph DJ. BJUI 2009; 104: 852–6. Reproduced with permission of John Wiley & Sons Ltd.)

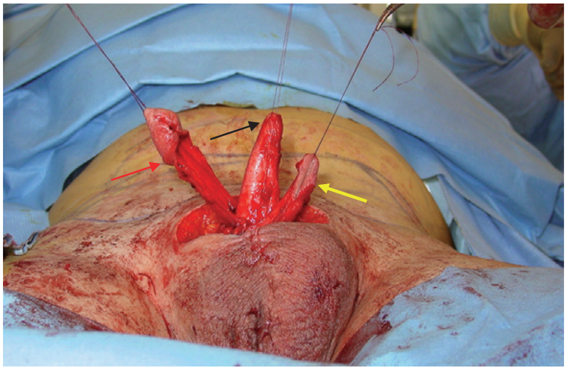

Figure 12.27 In patients with micropenis, the penis is disassembled. The urethra (yellow arrow) is dissected and spatulated to allow a primary anastomosis and the glans (red arrow) is preserved and incorporated in the base of the phallus to guarantee erogenous sensation. The neurovascular bundle is dissected off the corporal stumps (black arrow) and the dorsal nerves and deep dorsal vein are identified and prepared for eventual anastomosis.

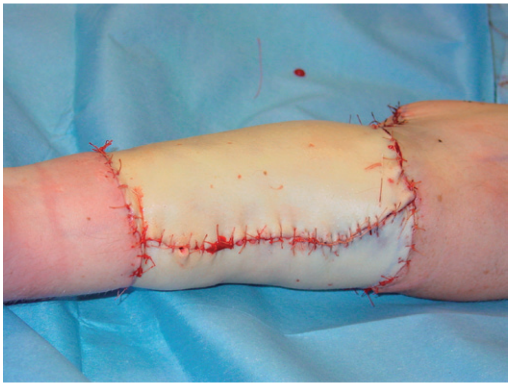

Figure 12.29 The defect on the donor site is covered with a full thickness skin graft (FTSG) harvested from the buttock or abdominal area. (Source: Garaffa G, Raheem AA, Christopher NA, Ralph DJ. BJUI 2009; 104: 852–6. Reproduced with permission of John Wiley & Sons Ltd.)

Microsurgical anastomosis

The inferior epigastric artery, long saphenous veins and iliohypogastric and ilioinguinal nerves are also identified and dissected. In the female-to-male transsexual, the recipient site is located on the pubic area, at the root of the clitoris. An inverted "U"-shaped flap is created in one of the labia minora and is anastomosed to the proximal portion of the phallic urethra. In female-to-male transsexuals, the native urethra is connected to the phallic one with the use of local labial flaps usually 3 months after the first stage.

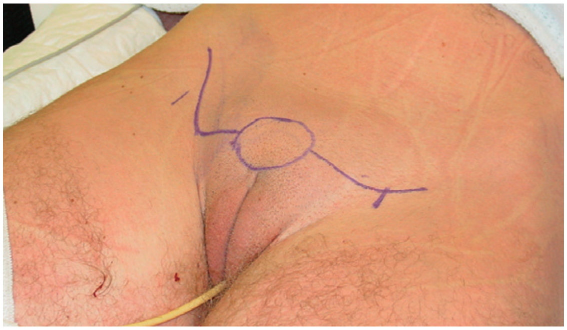

Figure 12.28 In female-to-male transsexuals, the recipient site is located in the pubic area, at the root of the clitoris.

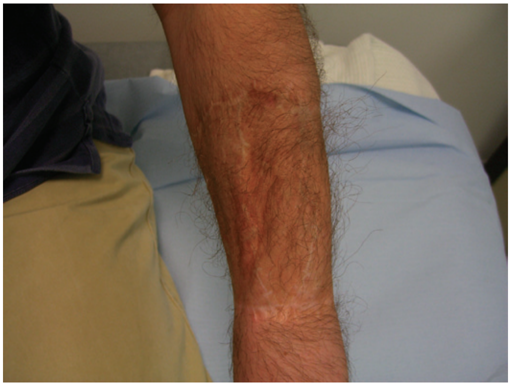

Figure 12.30 Final appearance of the donor site after 6 months. (Source: Garaffa G, Raheem AA, Christopher NA, Ralph DJ. BJUI 2009; 104: 852–6. Reproduced with permission of John Wiley & Sons Ltd.)

When the phallus is transposed to the recipient site, the following vascular, neural and urethral microsurgical anastomoses are performed with 8-0 nylon sutures:

1 *Arterial:* radial artery to deep inferior epigastric artery.

2 *Venous:* cephalic vein to long saphenous vein. Other flap veins to smaller saphenous vein branches are anastomosed. If the long saphenous vein has been previously excised during inguinal lymph node dissection, the flap veins are anastomosed directly to the femoral vein and/or to the deep dorsal vein of the penis.

3 *Neural:* cutaneous nerves to ilioinguinal, iliohypogastric or dorsal penile nerves

A median of two venous (range 1–5) and two neural (range 0–4) anastomoses are usually performed. The proximal end of the spatulated neourethra is primarily joined to the urethral stump and a suprapubic and urethral catheter is left *in situ* (Figures 12.29, 12.30, 12.31 and 12.32).

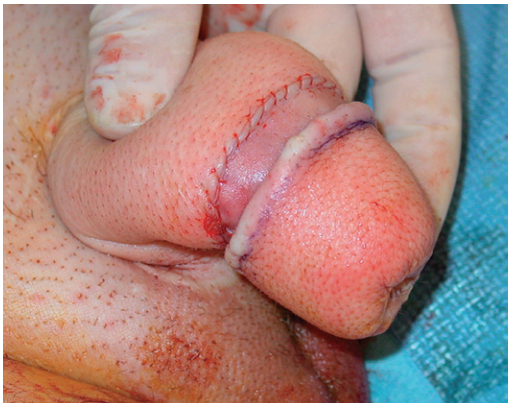

Figure 12.31 The glans is sculptured according to the Norfolk technique. A groove is created on the distal aspect of the phallus and the defect is grafted with an FTSG to form a coronal sulcus. During this stage the reservoir is inserted under open vision into the extraperitoneal space through the same inguinal incision used to harvest the FTSG for the glans sculpture. Once inserted, the reservoir is filled and the tubing capped off with a deactivation plug and left in the scrotal sac or in the lateral labia together with a testicular prosthesis.

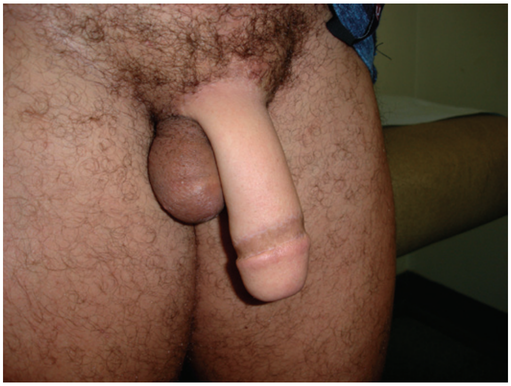

Figure 12.32 The final postoperative appearance of the phallus after 6 months. (Source: Garaffa G, Christopher NA, Ralph DJ. Eur Urol 2010; 57: 715–22. Reproduced with permission of Elsevier.)

After approximately 1 year, cutaneous sensation can develop and a mature capsule forms around the full reservoir. At this stage insertion of a penile prosthesis is performed.

Usually, a single cylinder, either CXR or narrow base (see Chapter 7) is implanted but if the phallus is bulky a second cylinder can also be used. Due to the absence of the tunica albuginea, the cylinder tips are housed in a Dacron® or Gore-Tex® tip to prevent distal erosion. If the crura of the corpora are present, then these can house the rear tips of the cylinders. The pump is then positioned in a subdartos pouch.

In the female-to-male transsexual and in all cases where the crura is absent, a Dacron® or Gore-Tex® sock is fashioned to house the rear of the cylinder with incorporation of the exit tubing. The cylinders are then inserted into the phallus through a groin incision. The previously inserted testicular prosthesis is removed and the pump placed into the capsule in order to allow for extra mobility of the pump which is then easier to use by the patient.

Pubic phalloplasty

This is a technically easier phalloplasty technique which does not require extensive surgery with a microvascular anastomosis followed by additional stages (Figures 12.33, 12.34, 12.35, 12.36, 12.37 and 12.38).

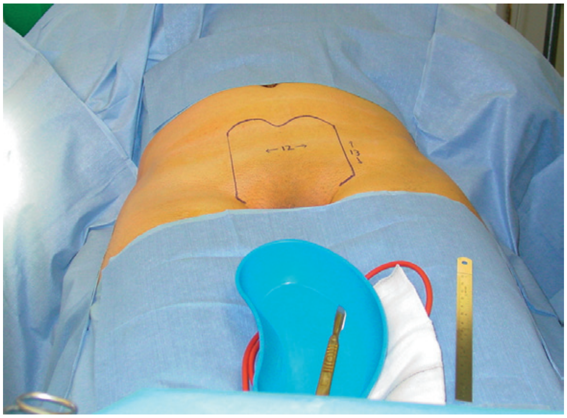

Figure 12.33 The flap dimensions are marked in the lower abdomen on skin which has undergone prior epilation using laser hair removal. The dimensions vary according to the level of obesity.

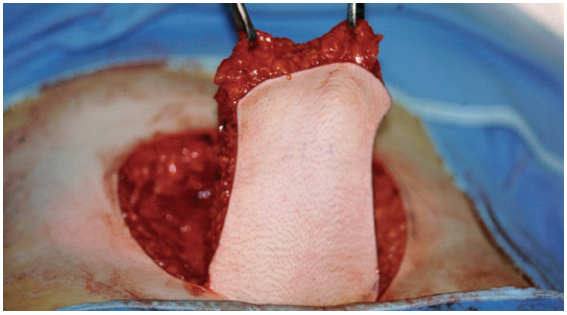

Figure 12.34 The flap is raised using the external pudendal vessels as the pedicle.

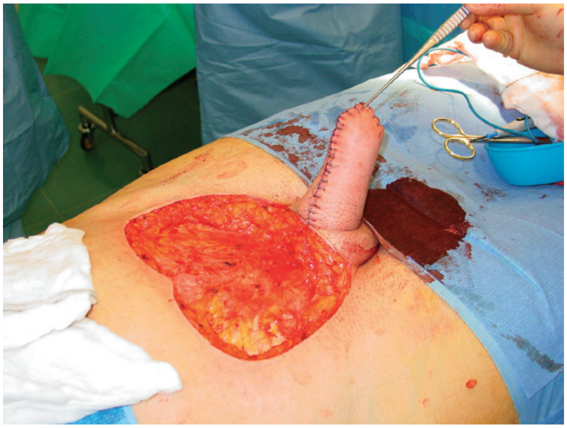

Figure 12.35 Once elevated the flap is tubularized to form a neophallus. The skin is sutured using 3-0 nylon interrupted sutures.

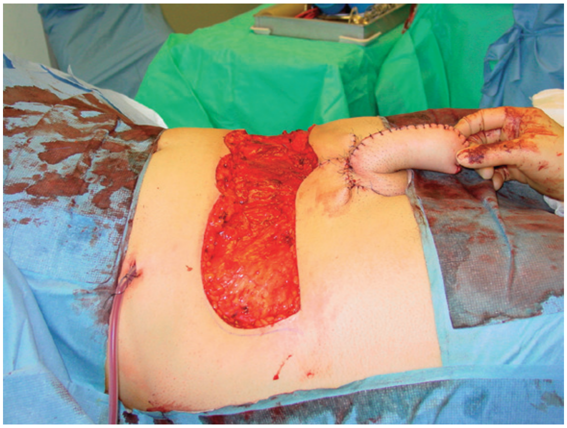

Figure 12.36 Bilateral rotational flaps cover the lower aspect of the abdominal defect.

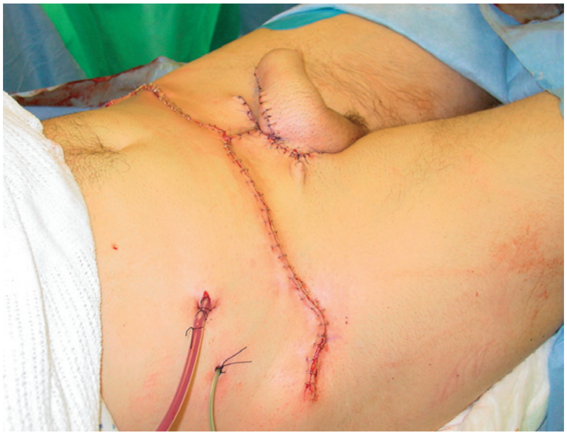

Figure 12.37 The upper abdominal flap is mobilized. The wound edges can now be sutured.

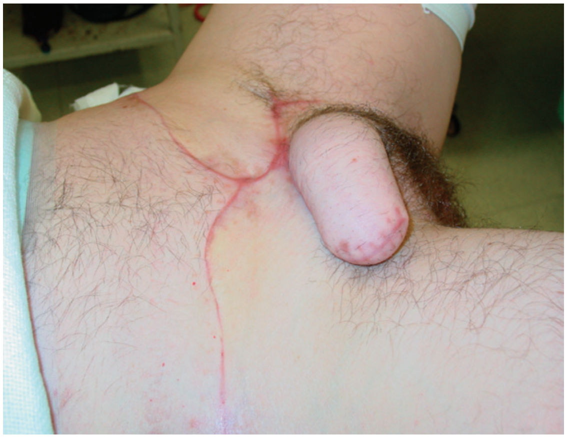

Figure 12.38 Postoperative result after 6 months.

Male genital lymphedema

Lymphedema of the genitalia arises when impaired lymphatic drainage results in the abnormal retention of lymphatic fluid within the subcutaneous tissues. Genital swelling may be limited to either the scrotum, penis or both. It may also be associated with generalized lower limb lymphedema.

Lymphedema can be classified as primary when the condition is a consequence of an abnormal development of the subcutaneous lymphatic system. Primary lymphedema is extremely rare and accounts for less than 5% of all cases. The lymphatic drainage of the genitalia occurs via the inguinal nodes bilaterally, therefore excision of the nodes or diseases afflicting the lymph nodes will result in genital lymphedema. The common conditions resulting in impaired lymphatic drainage are listed in Table 12.1.

Table 12.1 Conditions associated with impaired lymphatic drainage

Inguinal and pelvic lymphadenectomy
Trauma
Radiotherapy
Malignant and granulomatous infiltration
Venereal disease
Parasitic infection

Long-standing genital lymphedema results in recurrent cellulitis and a replacement of the elastic fibers by fibrous tissue.

Surgical management

Conservative management of primary genital lymphedema in the early stages involves broad spectrum prophylactic antibiotics, elevation and lymph-draining massage.

In severe chronic lymphedema surgical excision of the genital skin is required followed by reconstruction using local flaps and skin grafts. Although lymphangioplasty has been attempted, the results have been disappointing and therefore the management remains surgical.

Scrotal lymphedema

See Figures 12.39, 12.40, 12.41, 12.42 and 12.43.

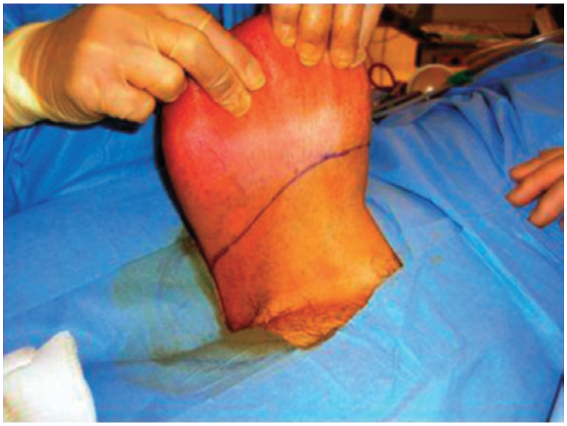

Figure 12.39 The lateral scrotal skin folds are unaffected by lymphedema. The lateral scrotal margin is marked.

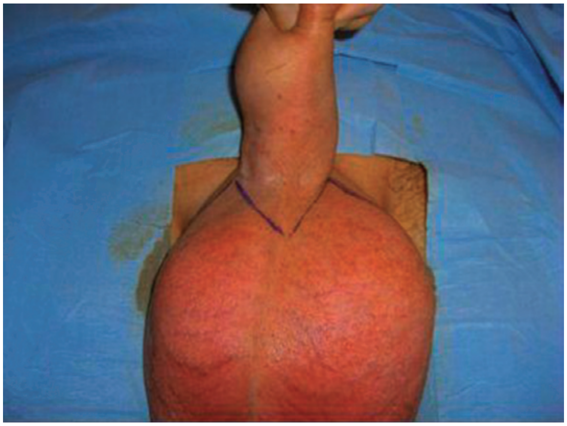

Figure 12.40 A scrotal inverted "W" incision is used. Dissection through the skin and dartos muscle is performed. Tissue is excised to the level of the tunica vaginalis.

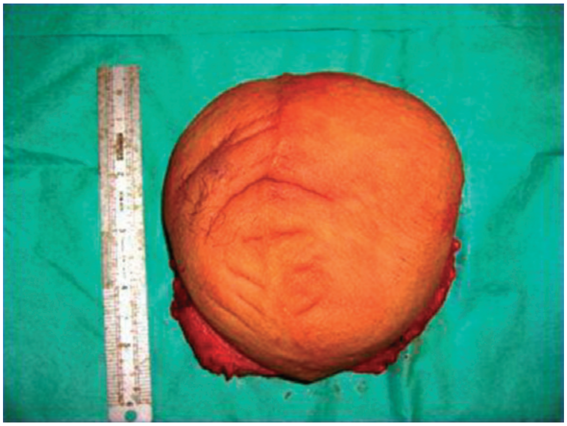

Figure 12.41 The scrotum is completely excised.

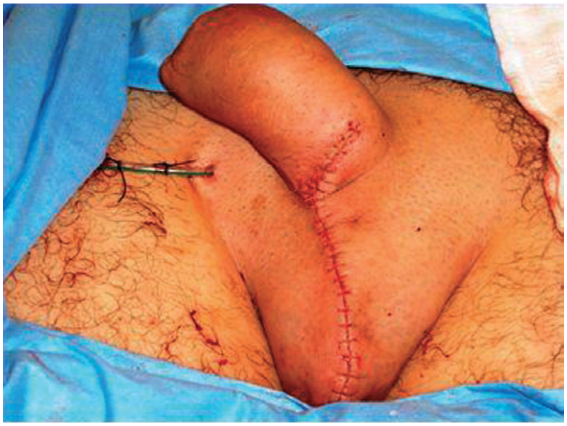

Figure 12.42 The defect is closed primarily by bringing together the lateral scrotal folds. 4-0 Nylon interrupted sutures are used for skin closure. A drain is inserted as the development of a seroma is likely.

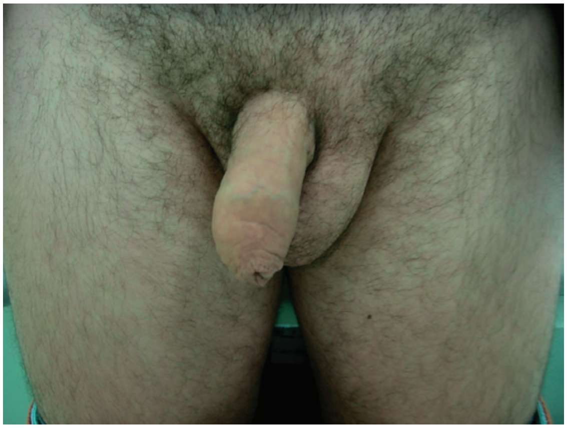

Figure 12.43 Postoperative result after 6 months.

Penile lymphedema

Solitary penile lymphedema requires excision of the lymphedematous tissue with reconstruction using a combination of the inner preputial skin which is unaffected by lymphedema and an FTSG. With regards to the penis, the inner layer of the prepuce has a separate lymphatic drainage along the dorsal neurovascular bundle towards the internal pudendal system whereas the remaining shaft skin drains in the inguinal lymph nodes. As a consequence the inner prepuce is never involved by the lymphedematous process and therefore it should be spared and used for penile shaft cover. Excision of the lymphedematous tissue down to the level of Buck’s fascia is required. Undermining the skin edges can disrupt the vascular supply to the skin resulting in skin necrosis.

Alternatively, once the lymphedematous tissue has been excised the penis can be placed under the scrotal skin for a 6-month period following which a flap of scrotal skin is used to cover the penile shaft. This technique is particularly useful in cases of self-injection of foreign substances into the penile shaft for augmentation purposes (Figures 12.44, 12.45 and 12.46).

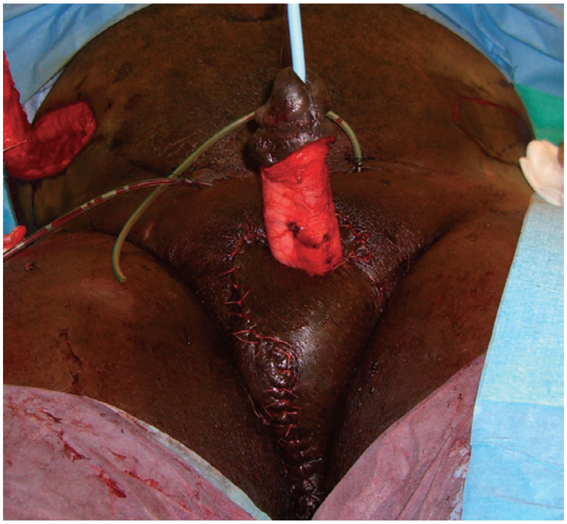

Figure 12.44 The abnormal skin and subcutaneous tissue is excised from the entire penile shaft to the level of Buck’s fascia.

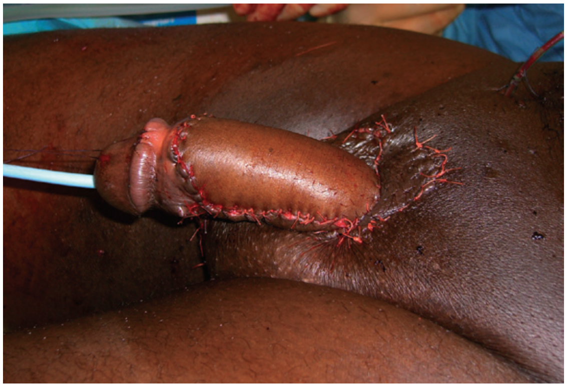

Figure 12.45 An FTSG is harvested and sutured to the penile shaft using 4-0 polyglactin sutures. Additional quilting sutures are used to immobilize the graft. Quilting sutures should be placed lateral to the urethra and lateral to the dorsal neurovascular bundle. Dressings are applied as described previously for 7 days.

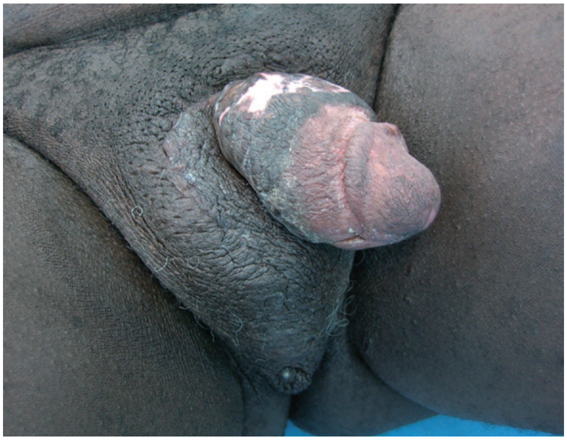

Figure 12.46 Postoperative result after 6 months.

Penoscrotal lymphedema

In cases of penoscrotal lymphedema, the scrotal lymphedema is surgically excised first as spontaneous resolution of the penile lymphedema can occur in some patients. Patients with scrotal lymphedema are better served with a total scrotectomy followed by repair using craniodorsal scrotal flaps. Because the craniodorsal aspect of the scrotum lacks lymphatic channels, it is spared by lymphedema. With time the skin flaps stretch leaving an excellent cosmetic and functional result. Attempts at scrotal preservation, with partial scrotectomy, are associated with a recurrence of the scrotal lymphedema in more than 40% of cases (Figures 12.47, 12.48, 12.49 and 12.50).

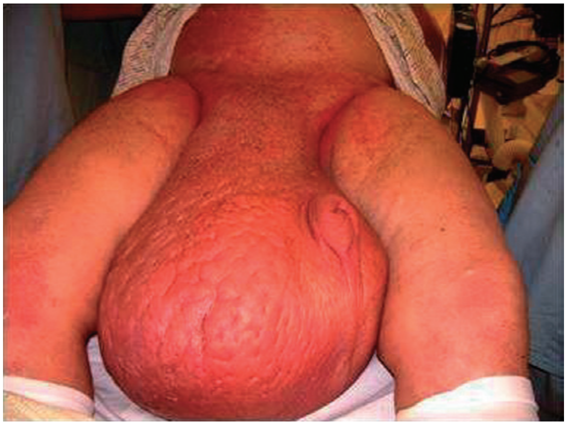

Figure 12.47 Extensive penoscrotal lymphedema.

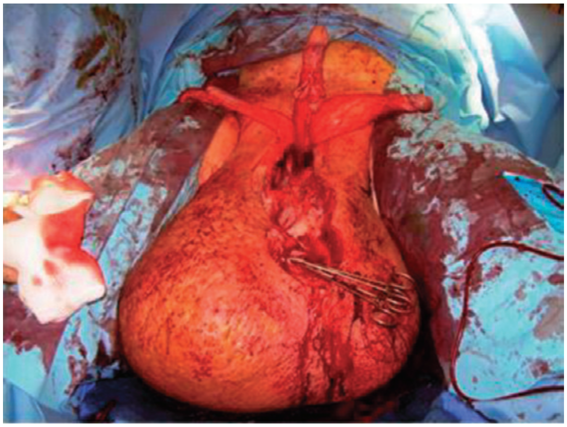

Figure 12.48 The spermatic cord is isolated and mobilized with the testicles bilaterally. The penile shaft is mobilized and protected. This allows excision of the scrotum without injury to the penile shaft and spermatic cord.

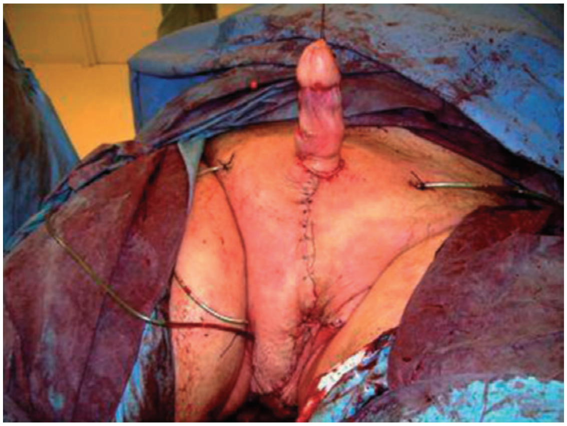

Figure 12.49 The scrotum is primarily closed using lateral scrotal flaps. The penile shaft is partially covered using the inverted inner preputial layer. An FTSG is harvested and used to cover the remaining penile shaft. The FTSG is quilted using 5-0 absorbable sutures.

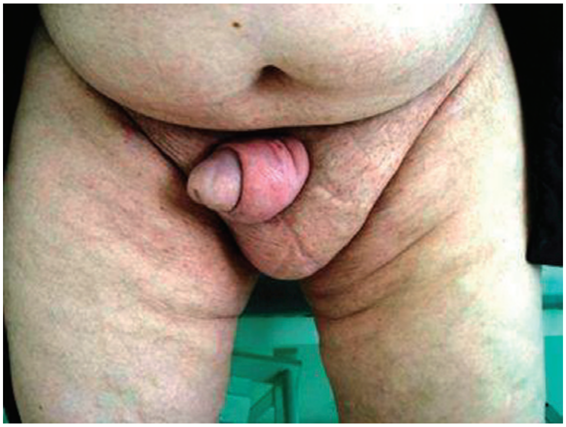

Figure 12.50 The postoperative result after 6 months.

References

1 Hadway P, Corbishley CM, Watkin N. Total glans resurfacing for premalignant lesions of the penis: initial outcome data. BJU Int 2006;98(3):532–6.
2 Song R, Gao Y, Song Y, Yu Y, Song Y. The forearm flap. Clin Plast Surg 1982;9:21.
3 Chang TS, Hwang WY. Forearm flap in one-stage reconstruction of the penis. Plast Reconstr Surg 1984;74:251–8.

Further reading

Garaffa G, Christopher AN, Ralph DJ. The management of genital lymphoedema. BJU Int 2008;102(4):408–14.
Garaffa G, Christopher NA, Ralph DJ. Total phallic reconstruction in female-to-male transsexuals. Eur Urol 2010;57(4): 715–22.
Garaffa G, Raheem AA, Christopher NA, Ralph DJ. Total phallic reconstruction after penile amputation for carcinoma. BJU Int 2009;104(6):852–6.

13

Surgery for Benign Scrotal and Foreskin Conditions

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Introduction

This chapter covers the most commonly occurring surgical conditions involving the scrotal contents and foreskin including: hydrocelectomy, excision of epididymal cyst, frenuloplasty, and circumcision. Clearly, there are many other alternative procedures but a familiarity with the commonest approach to the above conditions will certainly facilitate most of the other scrotal operations short of microsurgical reconstruction for obstructive azoospermia which is covered in Chapter 9. Each of these topics is addressed separately but as an introduction to this area it should be recognized that the scrotum is a vascular, rather elastic structure which may be deformed by hydroceles, cysts and tumor masses. The vascular supply is rich and therefore any approach through the scrotum must be considered carefully and meticulous hemostasis is critical to a successful surgical outcome.

Assessment

Assessment of the patient who has any scrotal abnormality is best performed with physical examination and should be carried out both in the standing and supine positions. One should begin on the "normal" side unless it is a bilateral problem. Cord structures should be carefully examined, in particular to identify the vas deferens. The epididymis should be felt along its entire length, and the testicle should be carefully palpated for any masses or other irregularity. The scrotum itself should be examined for any evidence of adhesion of underlying masses to the dartos layer and also for any other structural abnormalities of the scrotal skin. Urinalysis should be performed and all patients should also undergo a duplex scrotal ultrasound to delineate any other structural abnormalities including cysts, septations within a hydrocele, mass within the testicle or epididymis and abnormal vascular flow, either compromised, as with torsion, or increased, as with epididymitis.

Surgical management

The surgical management is discussed for each individual topic, but basically the scrotal surgical approach may be through a midline vertical incision in the scrotal raphe when bilateral exploration is indicated, or as a transverse incision over the anterior aspect of the hemi-scrotum, which will leave less of a visible scar and is less likely to transgress the scrotal skin's vascular supply. Again, meticulous hemostasis is necessary.

Surgical risks

The risks of scrotal surgery include recurrence of a hydrocele and epididymal cyst, as well as persistence of pain following epididymectomy and/or microsurgical cord denervation. Wound infection is uncommon and can be prevented with meticulous patient preparation, intraoperative antibiotics and use of postoperative

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antibiotics at the discretion of the surgeon. Post operative scrotal elevation is advised, and having the patient stay off his feet for several days may reduce swelling and thereby enhance healing, as well as reduce postoperative pain. Gentle postoperative compression dressings are advisable when the scrotum is operated on, but should not be left in place for longer than 24 hours. In addition, the patient who has an epididymal cyst and who is still interested in continued fertility should be counseled that any procedure in this area could potentially result in the obstruction of the epididymis and sperm transport.

Surgical outcomes

Surgical outcomes for the majority of these procedures is good and the majority of the procedures can be performed using local anesthesia. The greatest concerns for the patient will be the preservation of the blood supply to the testicle, resolution of pain if that is a preoperative issue and correction of the cosmetic deformity.

Vasectomy

Clinical features

Vasectomy is the most effective form of male sterilization. Various techniques have been described, but the underlying principle is to remove a satisfactory segment of the vas deferens, followed by closure of the proximal and distal ends of the remaining vas deferens. Patients should then be followed up to ensure that azoospermia is confirmed by semen analysis.

Surgical risks

When obtaining consent for a vasectomy, patients should be warned that the procedure is performed to prevent recanalization and is therefore deemed irreversible. Additional surgical risks include scrotal hematoma, wound infection and epididymitis. Patients should also be warned about the risk of late recanalization (1 in 2000), granuloma formation at the transected ends and the risk of post vasectomy pain syndrome (Figures 13.1, 13.2, 13.3 and 13.4).

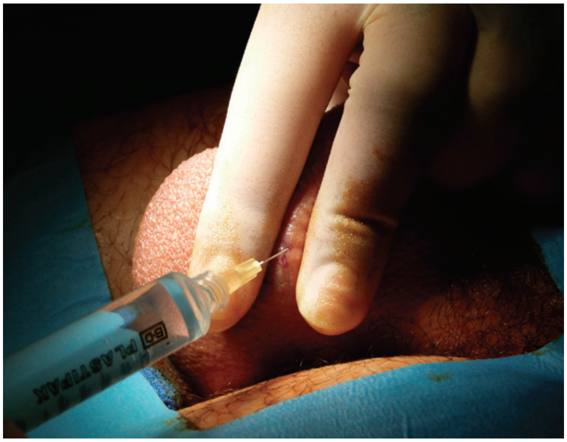

Figure 13.1 The vas deferens is identified by rolling it between the fingers, and is then gently grasped and fixed using a “three finger grip.” Using a 24-G needle, the skin is infiltrated using local anesthetic.

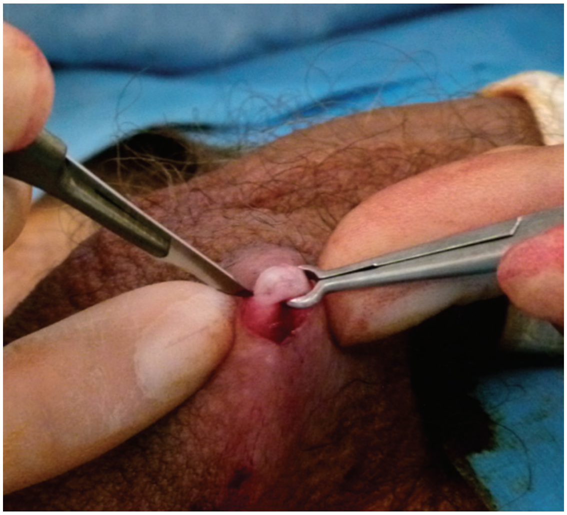

Figure 13.2 A 1-cm transverse skin incision is made over the vas while maintaining traction on the skin and gently pushing the vas and overlying tunica dartos through the incision. The dartos layer is spread using dissecting scissors or vasectomy forceps until the fascia over the vas is visualized. At this point care should be taken in order to prevent the vas from slipping out of position. The vas together with the fascial layers are then grasped using an Allis clamp or vasectomy forceps. The overlying external and internal spermatic fascia is incised longitudinally, gently dissecting it away from the vas.

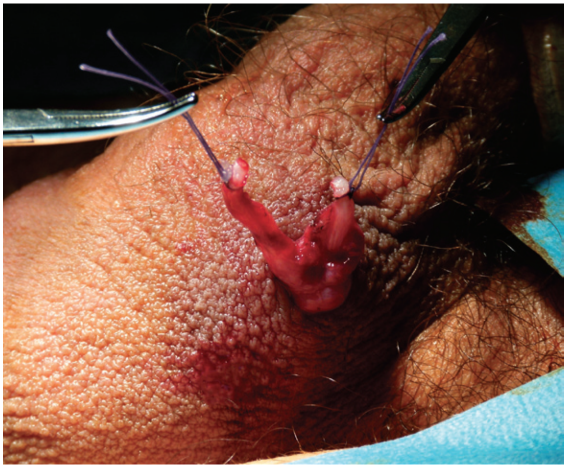

Figure 13.3 Between 1 and 2 cm of the straight part of the vas is isolated and this segment of vas is transected between the two artery clips. The transected ends can be tied with 3-0 polyglactin or transfixed with 2-0 monofilament sutures.

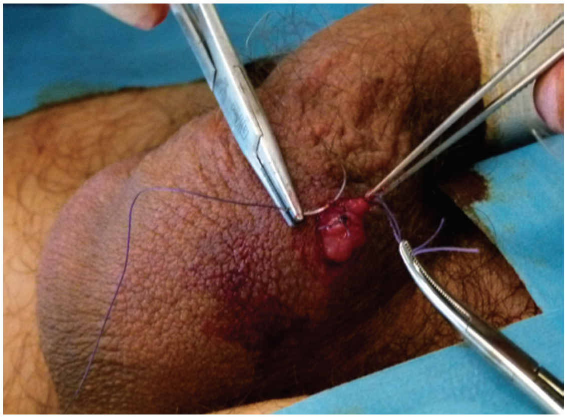

Figure 13.4 The remaining stumps are placed back into the scrotum and secured in different fascial planes. This is a key step to prevent recanalization. The internal spermatic fascia is used to cover the proximal vas. The distal stump is buried outside this fascia.

Postoperative care

Patients must continue to have protected sexual intercourse until azoospermia has been confirmed in an ejaculated semen sample. Early failure of the procedure either because of transection of the wrong structure (e.g. testicular artery) or because of a duplicated vas will be detected on the early semen analysis and the operation should be performed again.

Surgery for hydroceles

Clinical features

Hydroceles are a common benign condition involving the testicle and scrotum where excessive fluid accumulates between the visceral and parietal layers of the tunica vaginalis of the testicle. Hydroceles are commonly idiopathic, although other etiologies include tumor, trauma and infection. Rarely in the adult, the processus vaginalis remains patent, allowing fluid to descend from the peritoneal cavity and into the scrotum. Hydroceles may cause pain or localized pressure but most commonly cause painless deformity of the scrotum. This deformity can make sitting, standing, walking or exercise difficult. The precise pathophysiology has not been clearly established but appears to be either a result of excessive fluid formation by the tunica vaginalis secretory cells and/or inadequate reabsorption of the same fluid [1]. When the hydrocele becomes bothersome to the patient, treatment is indicated. Nonsurgical treatment includes aspiration or aspiration combined with sclerotherapy, but the most definitive approach is hydrocelectomy [2].

Surgical risks

Surgery for hydroceles is low risk and can be performed as a day case procedure. Hematoma formation is the most significant postoperative problem. Recurrent hydroceles are rare and form because of inadequate plication of the sac. Strangulation of the spermatic cord can occur if the sac is sutured too tightly behind the testicle.

Surgical technique

The most frequently performed procedures include a Lord's plication or a Jaboulay procedure. The Lord's plication procedure is described in Figures 13.5, 13.6 and 13.7. The Jaboulay procedure utilizes the same approach but rather than plicating the hydrocele sac, the tunica vaginalis is everted and sutured behind the testicle.

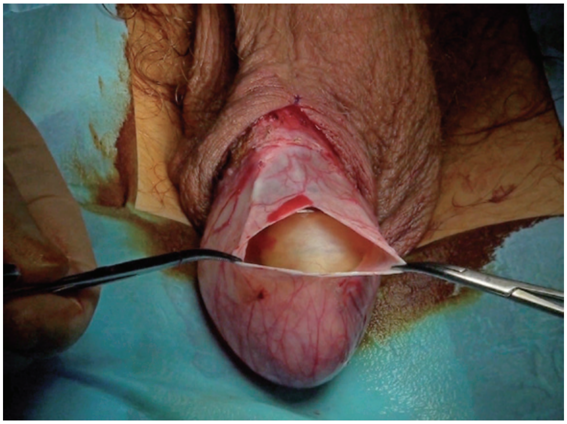

Figure 13.5 A midline scrotal raphe incision is used. Alternatively, a transverse incision parallel to the scrotal vessels can be used. The skin, tunica dartos and external spermatic fascia are incised until the hydrocele sac is identified. A small incision in the parietal layer of the tunica vaginalis releases the hydrocele fluid which is completely drained.

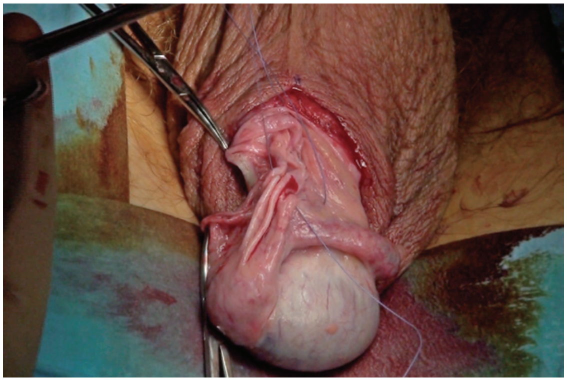

Figure 13.6 For a Lord's plication interrupted 3-0 or 4-0 polyglactin sutures are placed radially from the edge of the sac towards the testicle in order to plicate the hydrocele sac. Inadvertent injury to the epididymis and testicular vessels must be avoided.

Postoperative care

Following surgery for hydroceles, patients are at risk of hematoma formation. Therefore with very large hydroceles or in those cases that require excision of part of the hydrocele sac, a corrugated drain should be left *in situ* normally for 24 hours.

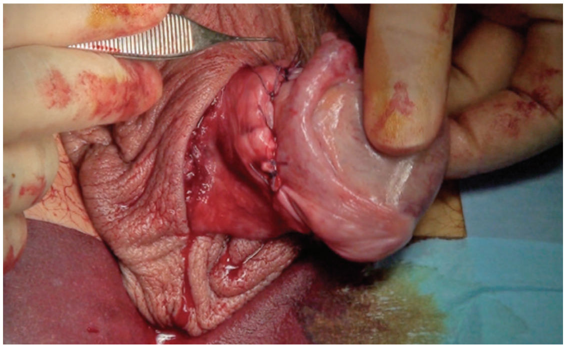

Figure 13.7 The plication sutures are tied individually and the sac is bunched up. Once the hydrocele sac has been plicated, the testicle is returned to the scrotum. A layered closure is performed of the dartos layer using 3-0 polyglactin sutures followed by 4-0 polyglactin sutures to the skin.

Epididymal cysts

Clinical features

Epididymal cysts are a common benign structure in the adult male. They may occur due to cystic fluid accumulation along the length of the epididymal tubule, but may also be caused by an aneurysmal dilatation of the epididymal tubule, which makes the cyst contain copious sperm. Because of the rich innervation on the surface of the epididymis and testicle, any distension of these structures will often be accompanied by pain which can be severe. Typically, once the cyst or spermatocele stabilizes, the pain will resolve. At that point the cyst typically remains the same, but may also grow or shrink but the pain is generally not problematic. When the cyst becomes particularly bothersome with respect to pain or scrotal deformity, then surgical excision is indicated. An alternative approach to excision is trans-scrotal aspiration although this is associated with a higher recurrence rate.

Surgical risks

Risks include hematoma formation and recurrent epididymal cysts. Where cysts arise close to the efferent ductules near the epididymal head, obstruction of these ductules can occur. Therefore, patients should be warned regarding the risk of obstruction to sperm at the level of the efferent ductules.

Surgical technique

See Figures 13.8 and 13.9.

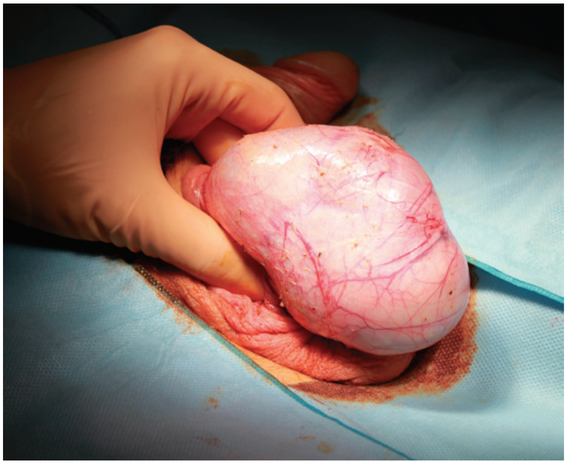

Figure 13.8 A midline scrotal raphe incision is performed with dissection through the tunica dartos and external spermatic fascia. The internal spermatic fascia and parietal layer of the tunica vaginalis remain intact as the testicle and cyst are delivered through the wound.

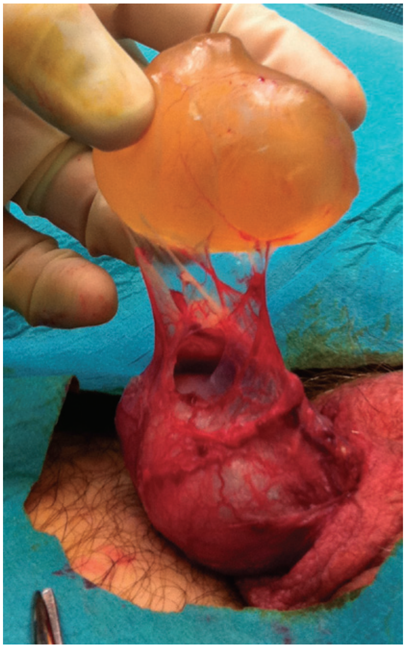

Figure 13.9 A distinct plane between the cyst and testicle is developed by incision of the internal spermatic fascia and parietal layer of the tunica vaginalis. The fascial layers are dissected using a combination of blunt and sharp dissection. The epididymal cyst is dissected down to the base and removed intact.

Epididymectomy

Clinical features

Epididymectomy is indicated when pain or a mass involves the epididymis. Most typically this would be following a vasectomy, thought to be caused by a congestive epididymitis. It is reasonable to offer this procedure to patients with pain that is isolated strictly to the epididymis and where it does not extend to the cord, paratesticular structures or the testicle itself. When the pain is more diffuse beyond the epididymis, medical pain management followed by local anesthetic injections should be offered, unless there is a coincidental mass within the epididymis which needs to be excised for pathologic assessment. The epididymis also has an important vascular network supplied primarily by the deferential artery, but is also supported by branches from the internal spermatic arterial network. Chronic bacterial inflammation or tuberculosis are also an indication for epididymectomy. Dissection of the epididymis from the surface of the testicle must be performed with great care so as to ensure that all of the efferent tubules are divided and sealed properly.

These tubules typically drain into the caput of the epididymis. Additionally, care must be taken to ensure that the vascular supply that supports the testicle is not compromised.

Surgical risks

A major risk of this procedure is devascularization of the testicle leading to testicular atrophy or need for orchidectomy. If the contralateral testicle is abnormal, there is a risk of infertility.

Surgical technique

The aim of this procedure is to completely remove the epididymis without compromising the blood supply to the testis. Indications for the procedure include symptomatic epididymal cyst, chronic epididymitis and epididymalgia that has failed conservative medical management (Figures 13.10, 13.11, 13.12, 13.13, 13.14 and 13.15).

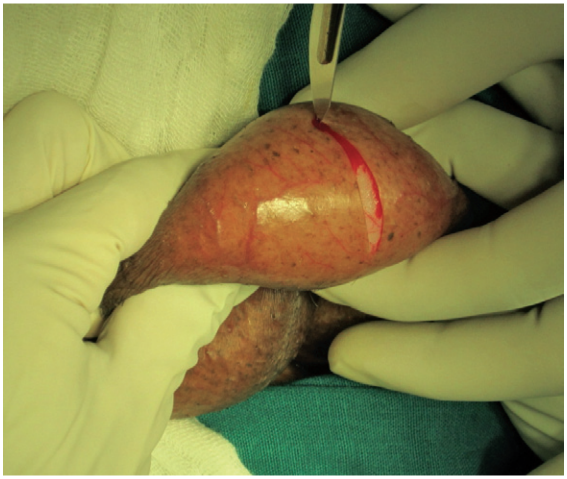

Figure 13.10 The testicle is brought taut to the anterior scrotal wall and a transverse incision between the scrotal blood vessels is performed. The tunica dartos is entered using a combination of electrocautery and sharp dissection to expose the tunica vaginalis.

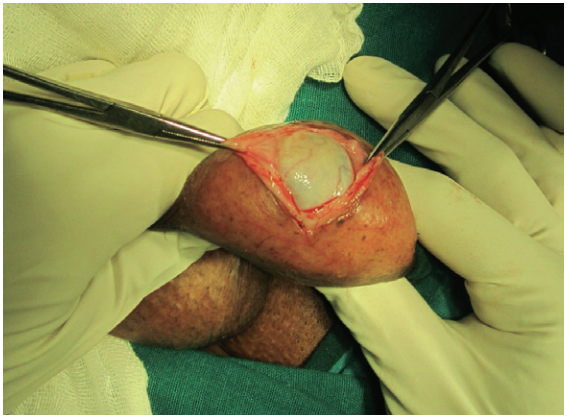

Figure 13.11 The tunica vaginalis is opened and the edges are secured with a hemostat. The testicle is then exposed through the incision.

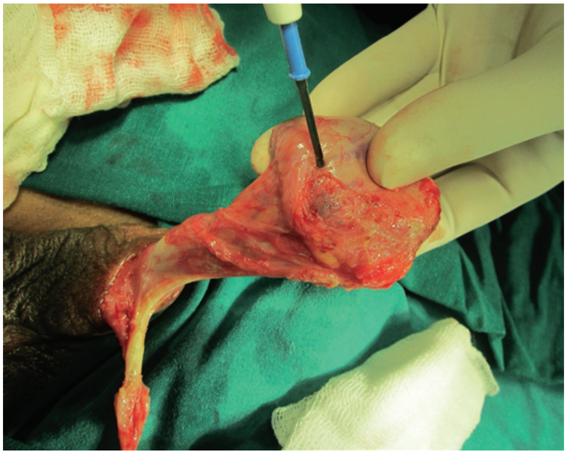

Figure 13.12 The tunica vaginalis is dissected off the epididymis and secured with a curved haemostat. The epididymal dissection can either start at the caput in the area of the efferent ductules, aided by inserting a traction suture onto the head of the epididymis, or alternatively dissection can start at the distal vas which allows more of the epididymis to be freed before encountering the testicular blood vessels and rete.

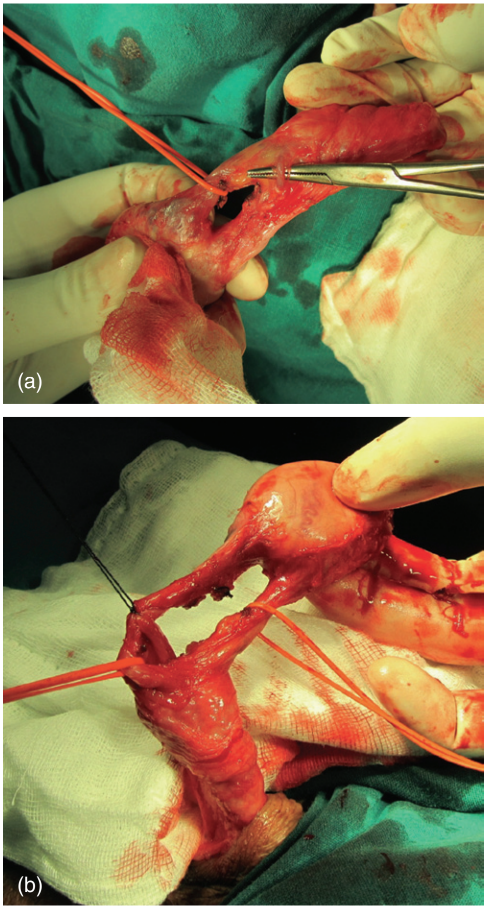

Figure 13.13 (a, b) The vas is separated from the remaining cord structures and followed to the tail of the epididymis. Keeping close to the epididymis the adjacent vascular structures are avoided as the dissection continues along the tail, body and toward the head of the epididymis.

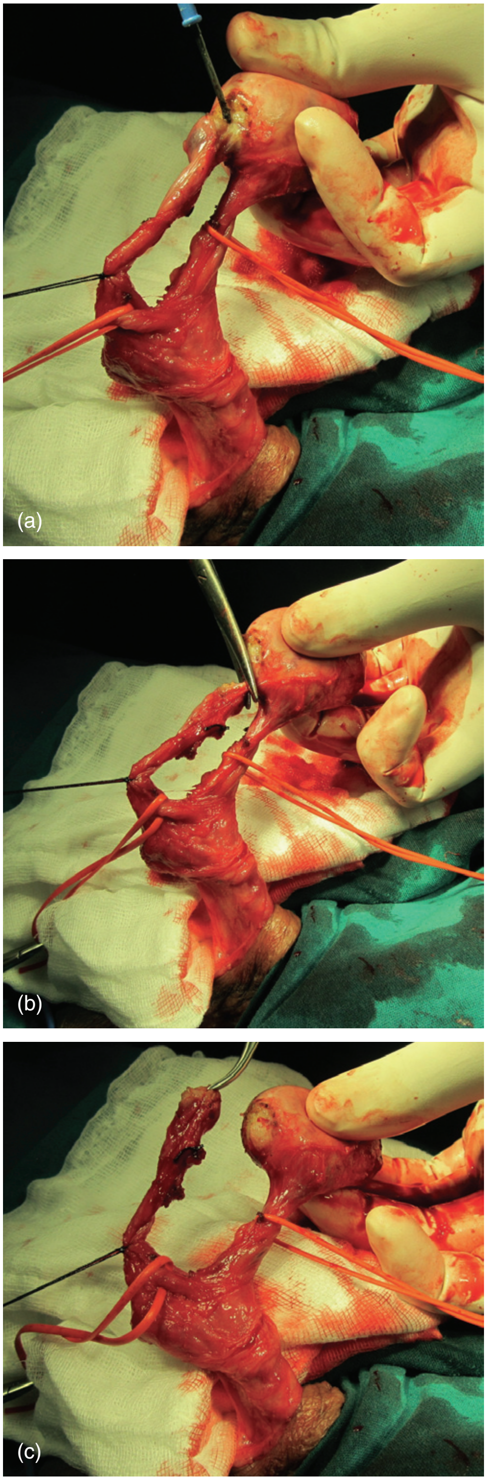

Figure 13.14 (a, b, c) The caput is dissected using a combination of sharp dissection and electrocautery.

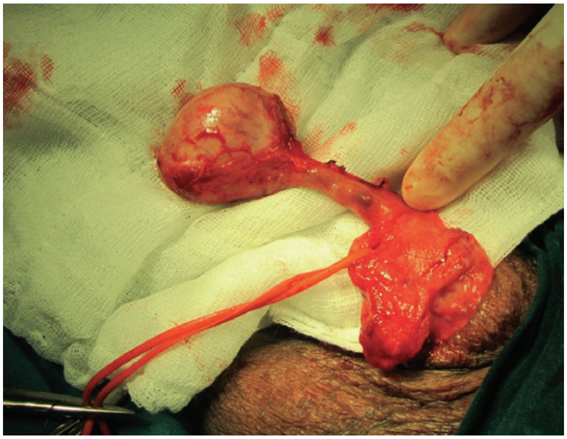

Figure 13.15 Final appearance of the testicle with epididymis removed and the cord structures intact. The defect over the bed of the epididymis is closed with a running 4-0 polyglactin suture. The testicle is returned to the scrotum and a layered closure of the tunica vaginalis, tunica dartos and scrotal skin is performed.

Microdenervation of the spermatic cord

Clinical features

Chronic scrotal content pain, often referred to as chronic orchialgia, is a condition that every practicing urologist who sees adult men will encounter in the clinic. These patients often seek the care of multiple physicians, as nonsurgical treatment options frequently fail. The etiology of this pain is most frequently idiopathic but may be a result of reversible causes such as intermittent testicular torsion, infection, tumor or trauma. The presenting features are chronic scrotal content pain including pain involving the testicle and/or epididymis and/or paratesticular and cord structures. These patients are usually initially treated with multiple courses of antibiotics, antidepressants and anti-inflammatories, with variable success.

When oral therapy fails, anesthetic blocks can be used with long-acting local anesthetics such as bupivacaine, to which corticosteroids may also be added. A variety of other nonsurgical approaches have been used, including acupuncture, TMR® (Scientific Imaginetics®, Beverly Hills, CA, USA), a form of pulsed high-frequency electromagnetic energy and pelvic floor physical therapy. Frequently, when the pain fails to respond to any of these measures, psychological support is indicated.

What has emerged over the past decade is that when there is no obvious reversible pathology and nonsurgical treatments fail, an alternative option is microdenervation of the spermatic cord (MDSC). This procedure is performed via a subinguinal incision, where the spermatic cord may be approached as it emerges from the external inguinal ring. Published reports on the success of this procedure have been impressive, in the 70–90% range with preservation of the testicle, which can be beneficial for the patient for both physiological and psychological reasons [3,4].

Surgical technique

Microdenervation of the spermatic cord

The aim of this procedure is to alleviate orchialgia by ablating the afferent nerve pathways contained within and around the spermatic cord while sparing the arterial supply (internal spermatic, cremasteric and deferential arteries). The microdenervation surgical approach is made through a 3–5 cm incision centered on the external inguinal ring, which can be identified with the examining finger through the upper aspect of the scrotum. Once the spermatic cord has been identified and isolated, an operating microscope is recommended for the remainder of the procedure. Several lymphatics are also spared to reduce the risk of postoperative hydrocele (Figures 13.16, 13.17, 13.18, 13.19 and 13.20).

Recent work has indicated that the greatest concentration of cord nerves are found around the vas deferens and arteries as well as within the cord fascia and cremaster muscle.

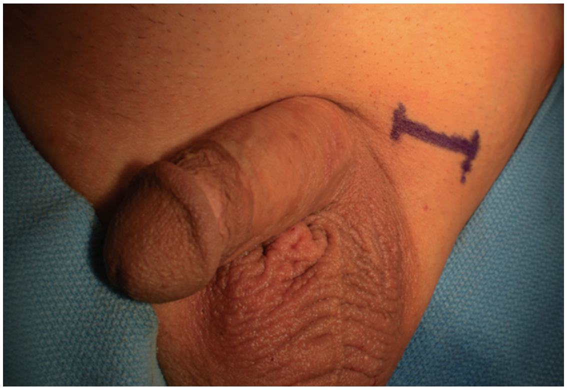

Figure 13.16 The external inguinal ring is identified with a finger through the upper aspect of the scrotum and a 4-cm incision is centered over the external ring which is taken down sharply so as to expose the spermatic cord.

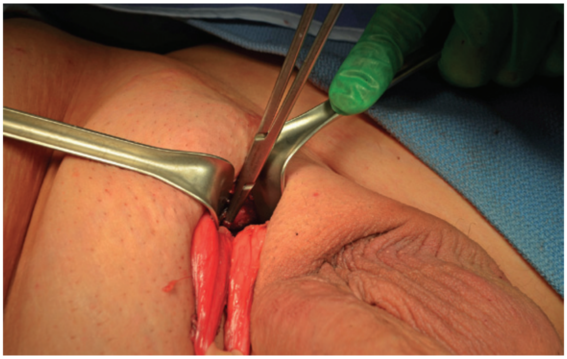

Figure 13.17 The ilioinguinal nerve is carefully dissected away from the spermatic cord, with the typical location emerging from the ventral or dorsolateral surface of the cord. A 2–3 cm segment of the nerve is excised and the cut ends are ligated with 4-0 silk to reduce neuroma formation.

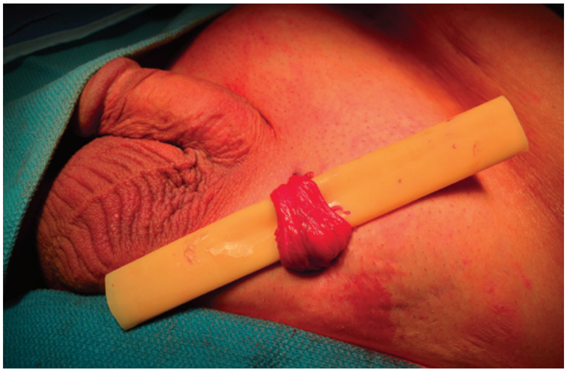

Figure 13.18 The spermatic cord is elevated and supported with a 5/8 inch Penrose drain which is secured to the drape. The operating microscope is brought to the field and dissection begins at 10–18× magnification. The anterior spermatic cord fascia is opened approximately 3–4 cm to expose the cord contents.

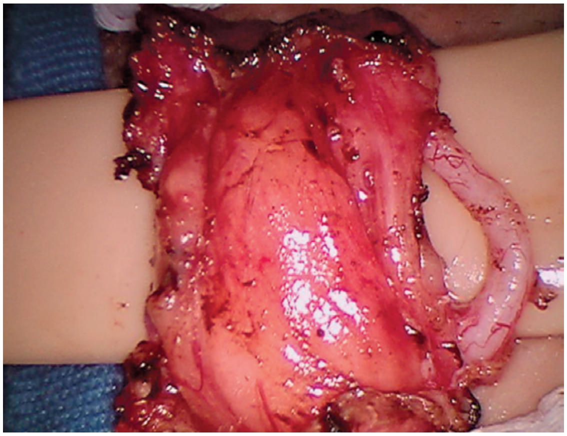

Figure 13.19 The edges of the spermatic fascia are secured to the Penrose drain to stabilize the cord and to enhance exposure. A 1.5–2 cm segment of the vas is stripped of its investing fibroareolar tissue including the deferential vessels. The deferential artery should be separated and spared, while the remaining perivasal tissue is divided. A vesiloop is placed around the stripped portion of the vas deferens. If the patient has had a previous vasectomy, the vas is divided again to ensure that any neural tissue in or on the vas is severed.

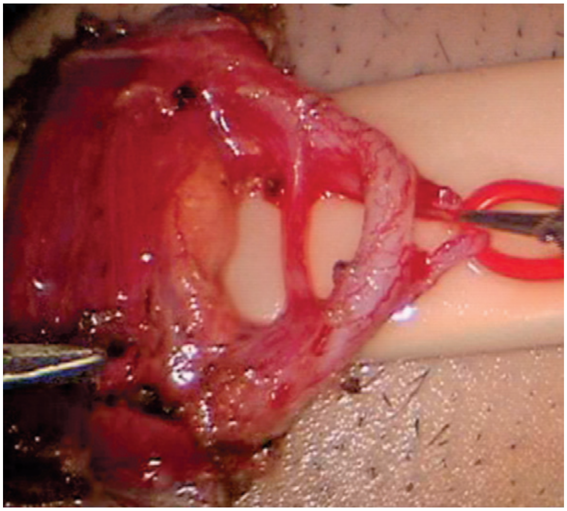

Figure 13.20 Lymphatics are preserved to reduce postoperative hydrocele formation. As the lymphatics are encountered they are secured with a vesiloop. The division of the spermatic fascia, cremaster fibers and fibroareolar tissue is completed to ensure destruction of microneural fibers including unmyelinated C and myelinated A-delta fibers. The Penrose drain is removed and the remaining tissue is allowed to return to its normal anatomic position. The field is irrigated with antibiotic solution; a local anesthetic block is injected. The inguinal wound is closed in three layers with two layers of running 3-0 polydiaxanone and a subcuticular 4-0 poliglecaprone.

Frenuloplasty

Clinical features

A tight frenulum is at risk of tearing and once torn patients complain of repeated tearing during sexual intercourse. A short frenulum can also result in ventral penile deviation. A frenuloplasty is a minor procedure that helps to release the tethering on the ventral aspect of the penis. Alternatively, for recurrent scarring in the frenular area or pathologic scarring due to lichen sclerosus, the frenular skin can be excised in a diamond shape and replaced using a full thickness skin graft (Figures 13.21, 13.22, 13.23, 13.24, 13.25 and 13.26).

Surgical risks

The main risk of surgery is postoperative bleeding. Reattachment of the frenulum may result in ongoing symptoms.

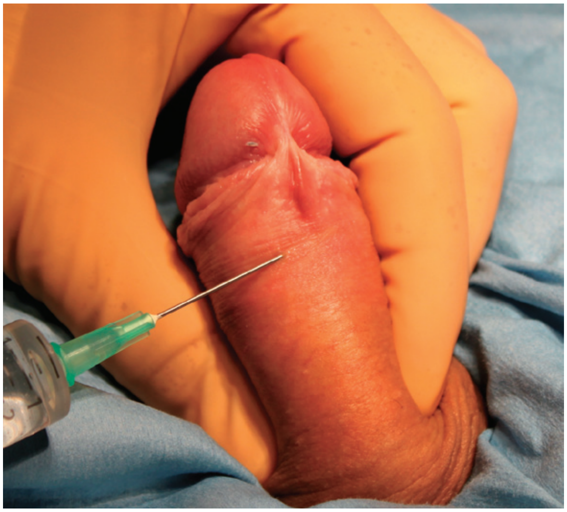

Figure 13.22 Local anesthetic infiltration of the frenulum.

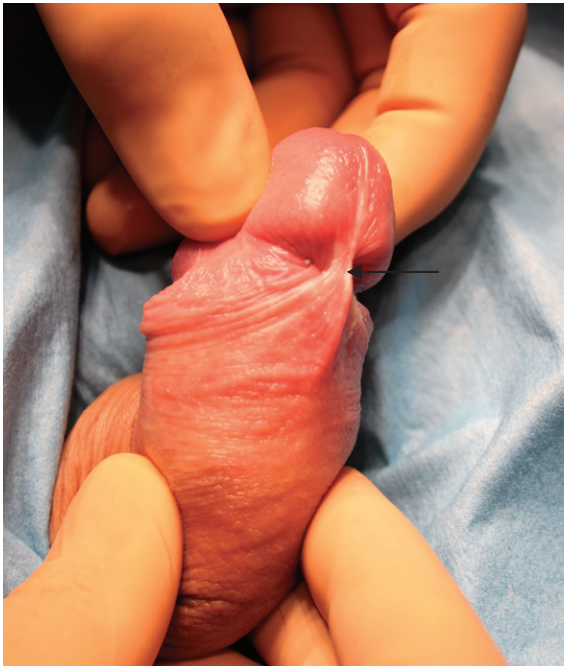

Figure 13.21 The frenulum is demonstrated by fully retracting the prepuce. The position of the band that is to be divided is demonstrated (black arrow).

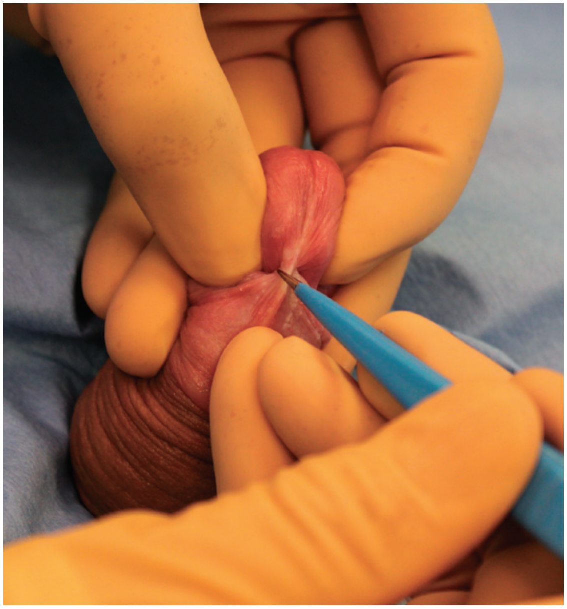

Figure 13.23 Bipolar diathermy can be used to coagulate the frenulum prior to incising the band. Diathermy should be performed well away from the glans epithelium.

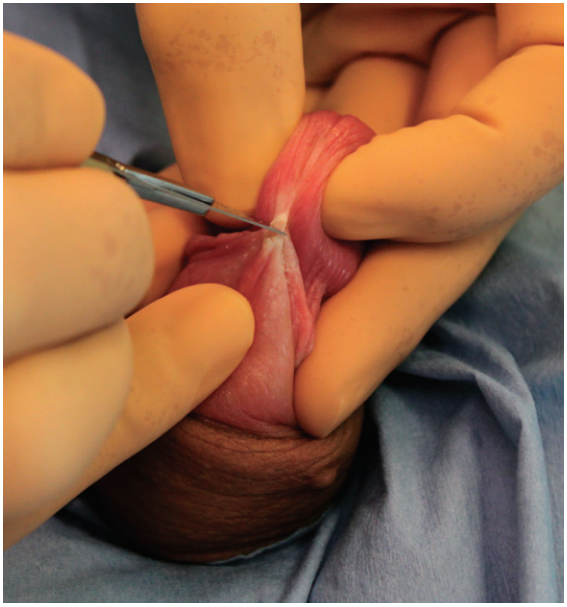

Figure 13.24 A transverse incision is performed to divide the band.

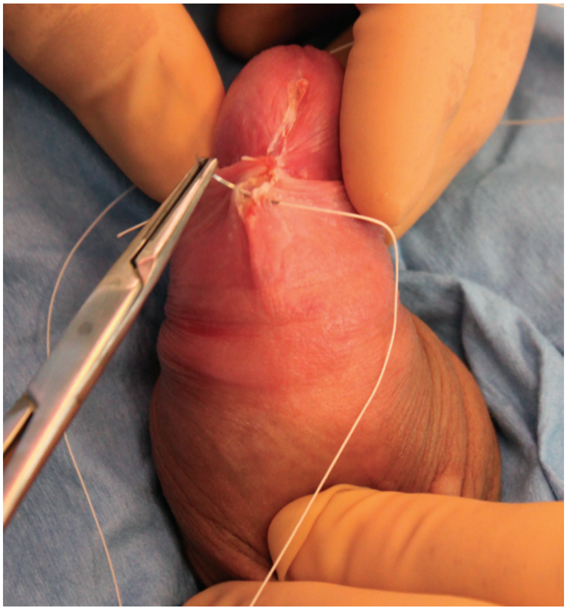

Figure 13.25 The resulting defect is sutured using 4-0 or 5-0 polyglactin sutures in a longitudinal direction. Sutures should not be placed too deep in order to avoid urethral injury.

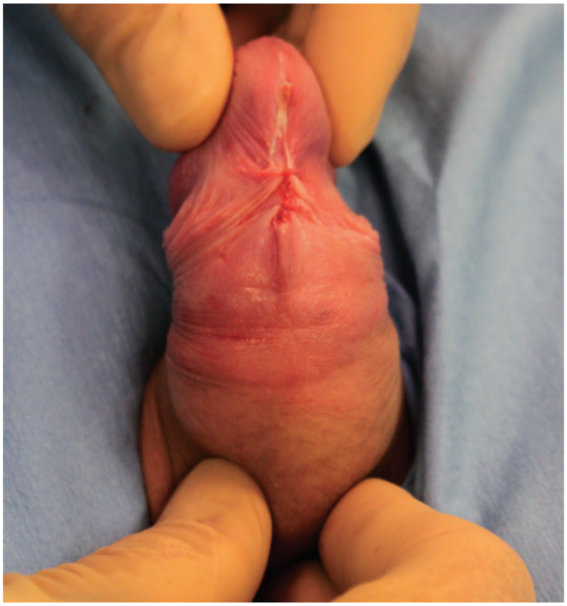

Figure 13.26 Final postoperative result.

Circumcision

Clinical features

Circumcision is one of the oldest surgical procedures described. Although neonatal circumcision is commonly performed for religious or cultural reasons, adult circumcision is performed in the presence of a pathological phimosis secondary to lichen sclerosus or following a dorsal slit for a paraphimosis. The procedure is also performed as part of penile straightening surgery whereby the penis is degloved to expose the underlying tunica albuginea. In premalignant diseases of the glans penis or preputial squamous cell carcinoma, a circumcision removes the entire prepuce together with the tumor and allows subsequent keratinization of the glans mucosa.

Surgical risks

Patients should be warned regarding the risks of postoperative bleeding, wound infection and a change in the sensitivity of the glans penis. Where there is extensive lichen sclerosus of the glans penis, meatal stenosis can also be present or occur later.

Surgical outcomes

When performed correctly the cosmetic result should be very good for the patient. Problems arise when there is inadequate preputial skin removal which can then overhang the glans penis and form a neoforeskin which is prone to further lichen sclerosus. If too much skin is removed then the penis can become buried and the penoscrotal junction is repositioned resulting in a subjective shortening of the penile shaft. Unsightly suture marks or lymphedema between the suture sites result from poor suturing technique and require a revision of the circumcision scar.

Surgical technique

The procedure can be performed under a local anesthetic or general anesthesia with the patient supine. The best cosmetic results are achieved by using a scalpel to incise the inner and outer preputial layer. Bipolar diathermy should be used throughout the procedure (Figures 13.27, 13.28, 13.29, 13.30, 13.31, 13.32 and 13.33).

Postoperative care

By ensuring meticulous hemostasis during the procedure, postoperative bleeding is rare. A nonadherent dressing and gauze is applied and patients are warned that the glans penis and wound is likely to become edematous postoperatively. Patients should avoid sexual intercourse until the sutures have absorbed.

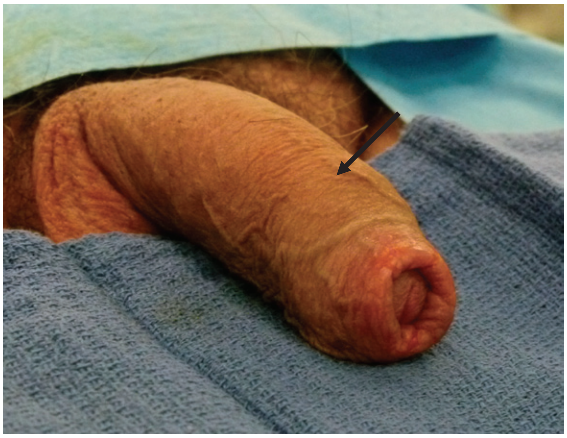

Figure 13.27 Penis and foreskin in the natural position prior to surgery. The position of the coronal sulcus is shown(black arrow) and this is used to direct the circumcoronal outer preputial incision.

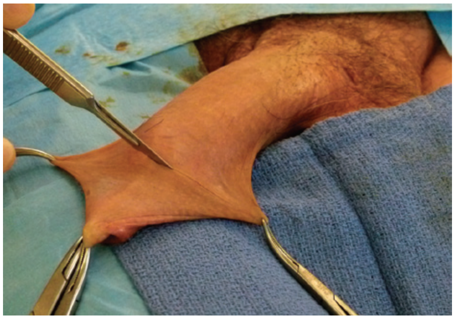

Figure 13.28 Two mosquito clips can be placed at the level of the glans corona at the 12 and 6 o'clock position and a further two mosquitos pull the prepuce forward. A size 15 scalpel is used to incise the skin and dartos fascia in an oblique line. The superficial dorsal vein of the penis is identified and ligated. This incision is repeated on the opposite side.

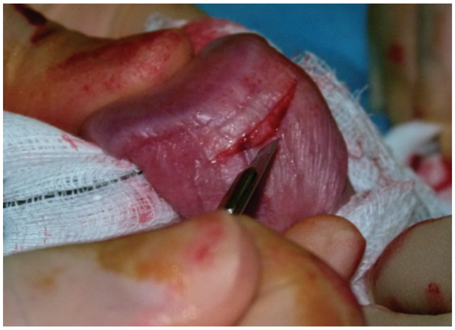

Figure 13.29 An inner circumcoronal incision is performed 5 mm from the edge of the corona. The frenulum is incised and bipolar diathermy is used to coagulate the frenular artery.

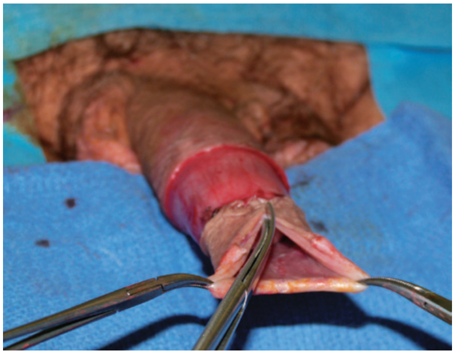

Figure 13.30 A dorsal slit is performed through the inner and outer prepuce to the level of the circumcoronal incision. Careful visualization of the external urethral meatus is required to ensure that the dissecting scissors do not enter the external meatus.

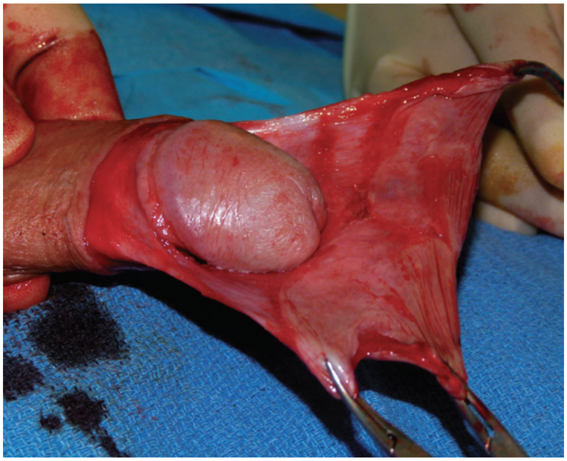

Figure 13.31 The foreskin can now be dissected under direct vision. The previous circumcoronal scalpel incisions guide the dissection.

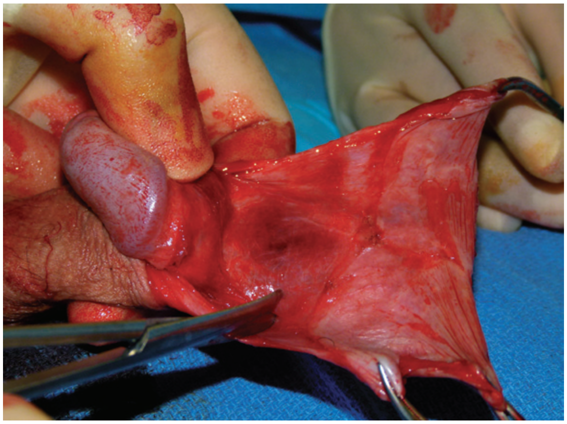

Figure 13.32 The fascial layers are dissected until the foreskin is removed completely.

Acknowledgment

Figures 13.10–13.15 were kindly provided by Professor Ganesh Gopalakrishnan, Consultant Urologist, Vedanayagam Hospital, Coimbatore, India. Additional photographs in Figures 13.16–13.20 courtesy of Dr Ahmet Gudeloglu and Dr Sijo J. Parekattil.

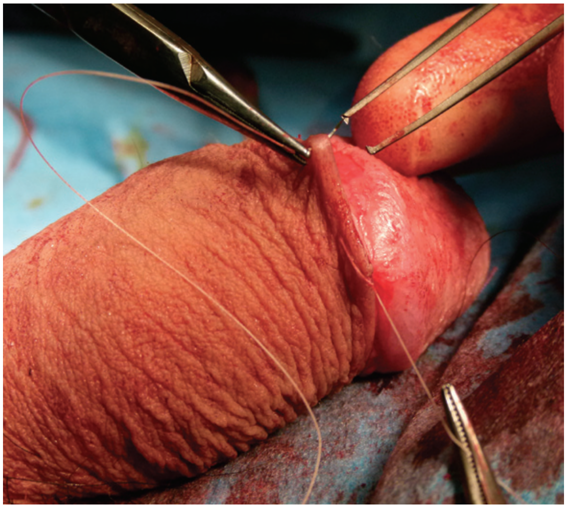

Figure 13.33 Interrupted 4-0 polyglactin sutures can be used to approximate the dartos layer. Interrupted 5-0 polyglactin sutures are used to approximate the skin edges. Initially, skin sutures are placed at 12 and 6 o'clock and then interrupted sutures are placed in between.

References

1 Huggins CB, Entz FH. Absorption from normal tunica vaginalis testis hydrocele and spermatocele. J Urol 1931;25:447.
2 Levine LA, DeWolf WC. Aspiration and sclerotherapy of hydroceles. J Urol 1988;139:959.
3 Strom KH, Levine LA. Microsurgical denervation of the spermatic cord (MDSC) for chronic orchialgia: Long-term results from a single center. J Urol 2008;180:949–53.
4 Heidenreich A, Olbert P, Engelmann UH. Management of chronic testalgia by microsurgical testicular denervation. Eur Urol 2002;41:392–7.

14

Surgical Management of Genitourethral Emergencies

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Introduction

Genitourethral emergencies may be secondary to ischemic, infective or traumatic conditions which require emergency surgery to minimize tissue damage and maintain long-term function. Failure to treat these conditions promptly and effectively can lead to significant loss of function, the need for major reconstructive surgery and even death in the case of Fournier's gangrene.

For the majority of these cases patients should undergo an immediate assessment followed by resuscitation. Antibiotic administration and confirmation of the patient's tetanus status is mandatory. For penetrating injuries, debridement of nonviable tissue is required before closure of the wound.

Testicular torsion

Clinical features

Testicular torsion is characterized by a sudden onset of severe pain in the hemi-scrotum which often radiates to the lower abdomen or flank. On examination the testicle may be lying in an abnormal position – high in the scrotum and/or horizontal. The patient may also provide a history of previous intermittent episodes of pain (partial or intermittent torsion) and there may be a history of minor trauma. Although neonatal torsion can also occur, the majority of testicular torsion cases present in men under the age of 40 years. Anatomically the high insertion of the tunica vaginalis is a risk factor for testicular torsion. The testicular blood vessels are twisted relative to the tunica vaginalis resulting in impaired venous outflow which eventually leads to hemorrhagic infarction in the testicle. Necrosis of the testicle occurs if left untreated.

Surgical management

An emergency scrotal exploration under general anesthesia, with untwisting of the spermatic cord will salvage the testicle if performed early enough. Both testicles are then fixed in the scrotum by suturing the tunica albuginea to the dartos muscle at three points. In pediatric cases, a sutureless fixation using a Jaboulay procedure following which the testicle is placed in a dartos pouch can also be performed (Figures 14.1, 14.2 and 14.3).

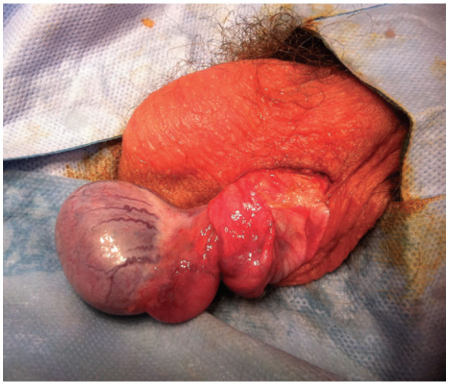

Figure 14.1 A midline raphe incision is performed. The tunica vaginalis is opened and the testicle is delivered through the wound and detorted. In this case the cord is torted relative to the tunica vaginalis resulting in testicular ischemia.

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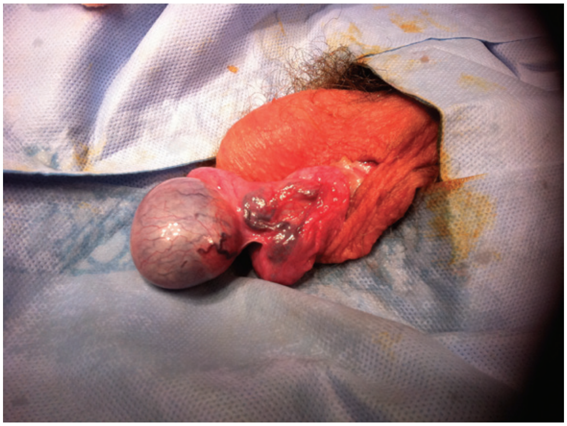

Figure 14.2 The testicle has been detorted prior to surgical fixation. If the testicle is viable then the tunica vaginalis can be everted and sutured behind the testicle and cord.

Surgical outcomes

Scrotal exploration and testicular fixation should be performed as soon as possible. If there is doubt about the viability of the testicle then it should be wrapped in warm swabs while the surgeon fixes the contralateral side. Only if there is subsequently no sign of perfusion should an orchidectomy be carried out.

Paraphimosis

Clinical features

Paraphimosis occurs when a tight and/or phimotic foreskin is retracted over the glans penis but then not returned into the normal position. This produces a tight ring proximal to the corona which causes progressive venous congestion, edema, ulceration and possible necrosis of the glans penis. Paraphimosis occurs most commonly in two age groups: teenagers and following catheterization in elderly men.

Surgical management

As soon as a patient presents with a paraphimosis, the foreskin should be pulled back into the normal anatomic position. In order to perform this successfully, the edema between the phimotic ring and the corona must be reduced first in order to allow the foreskin to return to its original position. The edema can be reduced by gentle manual compression (Figure 14.4). There is evidence that placing ice often helps, providing some element of anesthesia. Failure to pull the foreskin into the normal position will necessitate surgical intervention whereby a

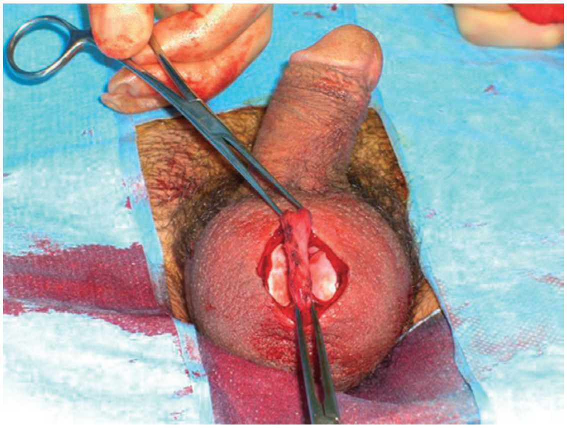

Figure 14.3 The testicle is sutured to the dartos muscle at three different locations using 5-0 polypropylene sutures. A three-point fixation of the contralateral testis is also performed as the high insertion of the tunica vaginalis is frequently bilateral. Closure is carried out in layers using 4-0 polyglactin sutures.

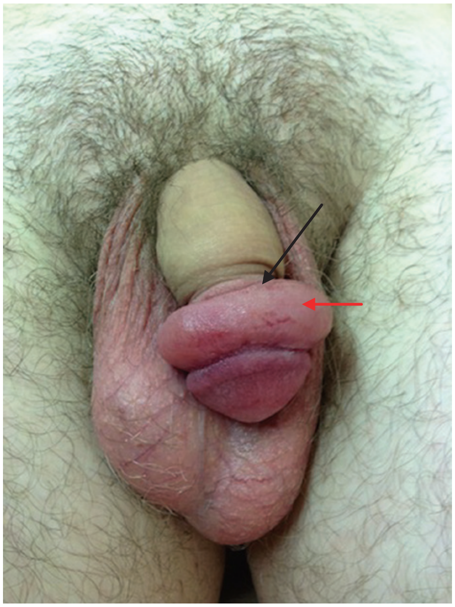

Figure 14.4 If the paraphimosis cannot be easily reduced manually, a ring block or penile nerve block using 1% lidocaine is performed. A 25-gauge hypodermic needle can then puncture the edematous tissue (red arrow) in several places to allow fluid to drain. Digital pressure is then applied to the edematous foreskin until the fluid has drained out. This may take several minutes. At the same time the phimotic ring (black arrow) is brought over the edematous tissue and glans penis.

small longitudinal incision under local or general anesthetic is performed on the tight band and the foreskin is brought forward into the normal position. 4-0 polyglactin sutures are used to suture the skin.

Surgical outcomes

A paraphimosis that has been present for less than 24 hours can be manually reduced with some cases requiring local anesthesia. However, in cases of longer duration, significant edema is present which prevents the foreskin from being pulled forward. Following successful management, patients should be examined again after a few weeks in order to assess whether a circumcision is required.

Priapism

Priapism is a persistent penile erection with a duration of longer than 4 hours in the absence of sexual stimulation and persists despite ejaculation. The incidence has been quoted to be 1.5 cases per 100,000 person years. Priapism is classified as ischemic (low flow), nonischemic (high flow) or intermittent (stuttering). An ischemic priapism requires urgent treatment otherwise necrosis of the cavernosal smooth muscle will occur leading to fibrosis of the cavernosal smooth muscle and ultimately erectile dysfunction.

Nonischemic priapism is less common and is associated with penile and perineal trauma which results in a traumatic arteriocavernosal fistula. It is often painless, and does not require emergency intervention as long as the diagnosis is accurate.

Clinical features

Ischemic priapism presents as a painful erection due to the blood in the corpus cavernosum being hypoxic and acidotic. Although over 30% of cases are idiopathic, common risk factors include sickle cell disease, antipsychotic agents, intracavernosal prostaglandin injections and malignancy. Doppler ultrasound studies will confirm poor perfusion in the corpus cavernosum and this is confirmed by aspirating blood from the corpus cavernosum which is typically hypoxic and acidotic.

Nonischemic priapism may occur several weeks following the trauma which is often a straddle type injury or direct penile or perineal trauma. In these cases the erection is either painless or intermittently uncomfortable. In nonischemic priapism the blood within the corpus cavernosum is well oxygenated with a normal pH and therefore ischemic necrosis of the corpus cavernosum smooth muscle does not occur. Doppler ultrasound in these cases shows an increase in the peak systolic velocity in the cavernosal artery. Analysis of aspirated blood from the corpus cavernosum shows a normal pO_2 and pH.

Although poorly understood, recurrent priapism is common in patients with sickle cell disease although idiopathic stuttering priapism is now also increasingly recognized. This condition normally occurs nocturnally and there is a failure of detumescence on waking. Erections become painful if the duration exceeds 1 hour.

Surgical management

Priapism is a surgical emergency. In ischemic priapism the hypoxia and acidosis must be reversed followed by cavernosal smooth muscle contraction in order to induce and maintain penile detumescence. The instillation of α adrenergic agonists to induce contraction of the corpus cavernosum and the helicine arteries which in turn reduce the volume of stagnated blood and therefore relieve the pressure on the subtunical venules can ultimately lead to detumescence. The most common α adrenergic agonist used is phenylephrine at a repeated dose of 200–500 µg. Careful monitoring of the patient's blood pressure is required as the adrenergic effects of the drug on the systemic circulation can lead to systemic hypertension.

If the priapism fails to resolve despite these measures then further surgical intervention is required to achieve detumescence. The underlying physiologic basis of surgical interventions is to divert ischemic blood from the corpus cavernosum into the venous system by developing a new channel of blood flow. The main surgical procedures that have been utilized are listed in Table 14.1.

In cases of nonischemic priapism, conservative management is initially attempted. Patients can be kept on surveillance for a few weeks or an attempt to compress

Table 14.1 Surgical shunt procedures for ischemic priapism

Year	Technique
1964	Quackle procedure
1964	Grayhack procedure
1975	Ebbehoj procedure
1976	Winter shunt
1976	Barry procedure
1981	Al Ghorab procedure
2008	Lue T shunt and tunneling

the fistula with an ultrasound probe can be undertaken. However, if conservative management fails then arteriography and super-selective embolization of the fistula is required.

Surgical outcomes

Provided that the ischemic priapism is treated promptly, penile detumescence is successful and erectile function is preserved. However, for prolonged cases smooth muscle necrosis leads to failure of conventional treatment with α adrenergic agonists and shunt procedures are required. However, despite penile detumescence following shunt procedures the potency rate is only 10%. Therefore these patients often require a penile prosthesis insertion as a delayed procedure.

Surgical techniques

Once the diagnosis of ischemic priapism is made, prompt aspiration of blood and instillation of an α adrenergic agonist should be performed, particularly in cases that have a duration of less than 24 hours. Historically, failure of aspiration and α agonist instillation has been followed by performing one of several shunt procedures which divert blood from the corpus cavernosum to the glans, corpus spongisum or saphenous vein. These shunts have a variable success rate and are unlikely to be successful in cases of prolonged priapism (more than 72 hours). Priapism that lasts 24–72 hours has a variable outcome and it is a matter of debate as to whether in the long-term potency is maintained if shunt surgery is successful in achieving penile detumescence. The longer the duration of priapism, the greater the degree of smooth muscle dysfunction due to necrosis, which eventually results in cavernosal fibrosis. For this reason an option is to perform an insertion of a malleable implant early in order to maintain penile length and avoid a delayed insertion when the penis is fibrotic, which is associated with difficult implant placement (Figures 14.5, 14.6, 14.7, 14.8, 14.9, 14.10 and 14.11).

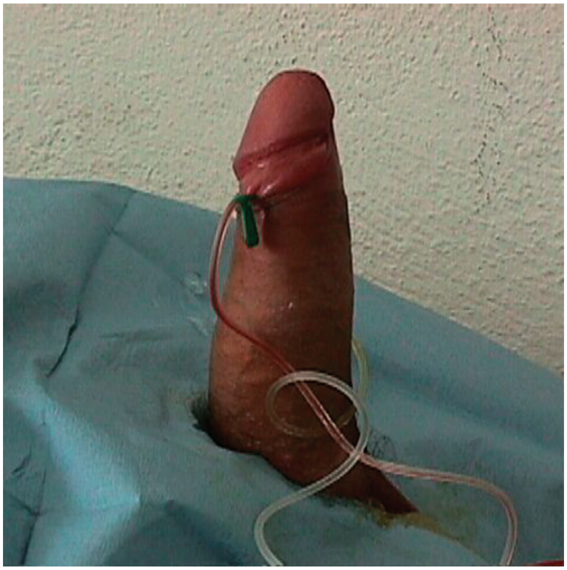

Figure 14.5 Aspiration of blood from the corpus cavernosum before instillation of an α agonist can be performed using a 21-G butterfly needle directly into the corpus cavernosum or inserted into the corpus cavernosum through the glans penis. Failure of detumescence following aspiration and α agonist instillation should be followed by shunt procedures.

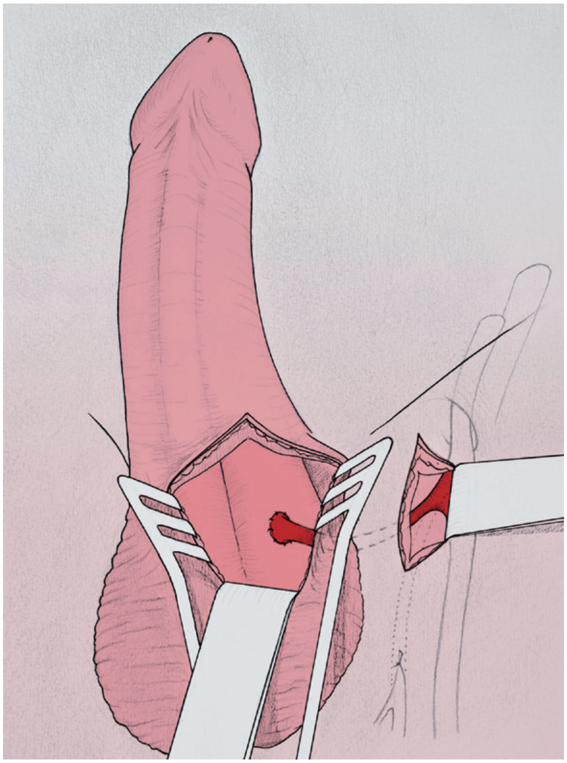

Figure 14.6 The Grayhack procedure involves creating a shunt between the corpus cavernosum and the long saphenous vein by tunneling the vein from the upper thigh to the proximal corpus cavernosum. (Source: Tor Ercleve. Reproduced with permission of Tor Ercleve.)

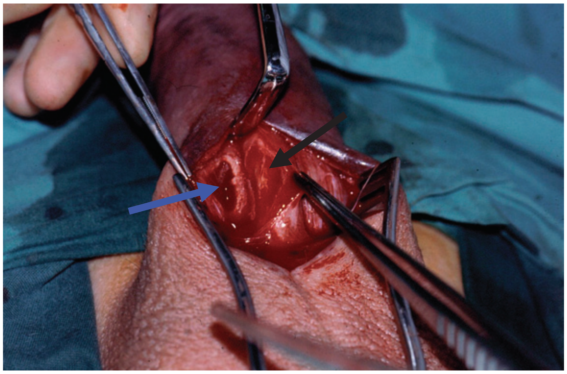

Figure 14.7 The Quackle procedure involves a unilateral corporotomy (blue arrow) which is anastomosed to the corpus spongiosum (black arrow).

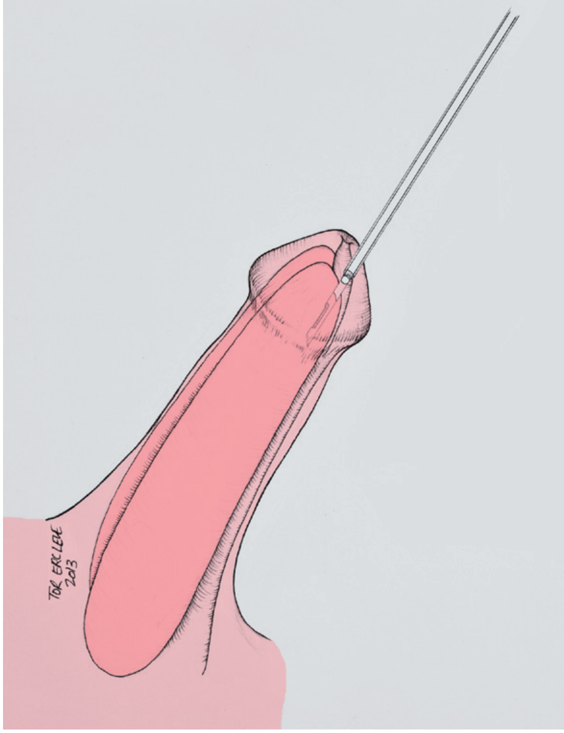

Figure 14.9 A Winter shunt is similar to the Ebbehoj procedure except that a Tru-Cut needle is inserted into the glans and corpus cavernosum. (Source: Tor Ercleve. Reproduced with permission of Tor Ercleve.)

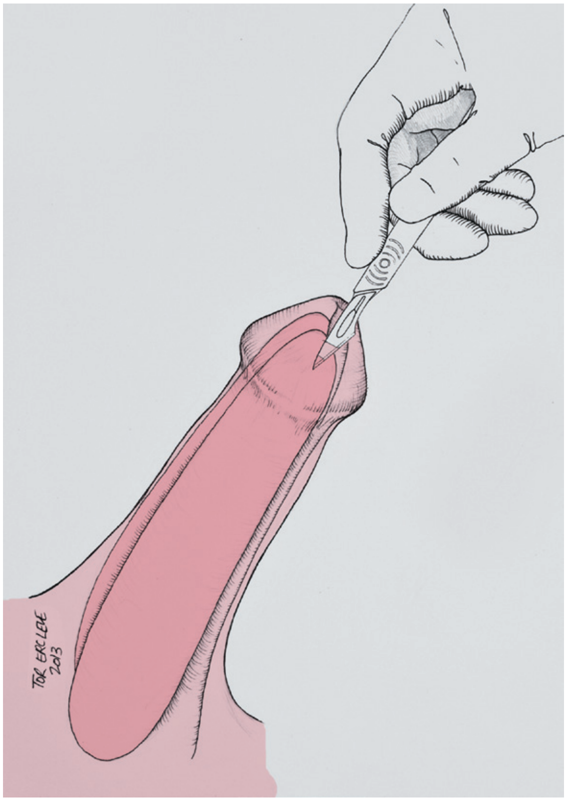

Figure 14.8 The Ebbehoj procedure creates a shunt between the glans penis and the corporal head by inserting a No 11 scalpel through the glans penis and into the tip of the corpus cavernosum. (Source: Tor Ercleve. Reproduced with permission of Tor Ercleve.)

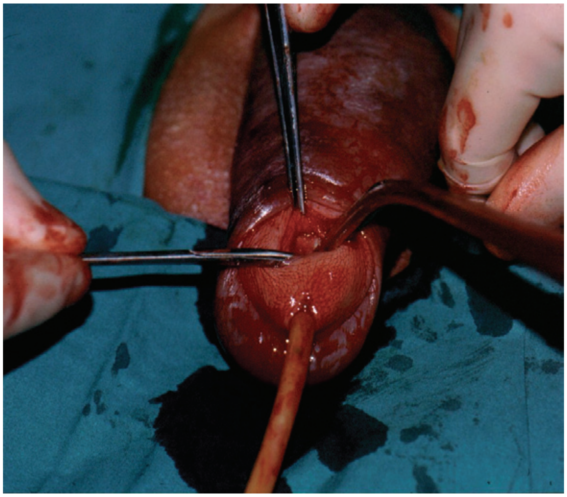

Figure 14.10 The Al Ghorab procedure creates a shunt between the glans penis and the tip of the corpus cavernosum by excising a small amount of tunica albuginea.

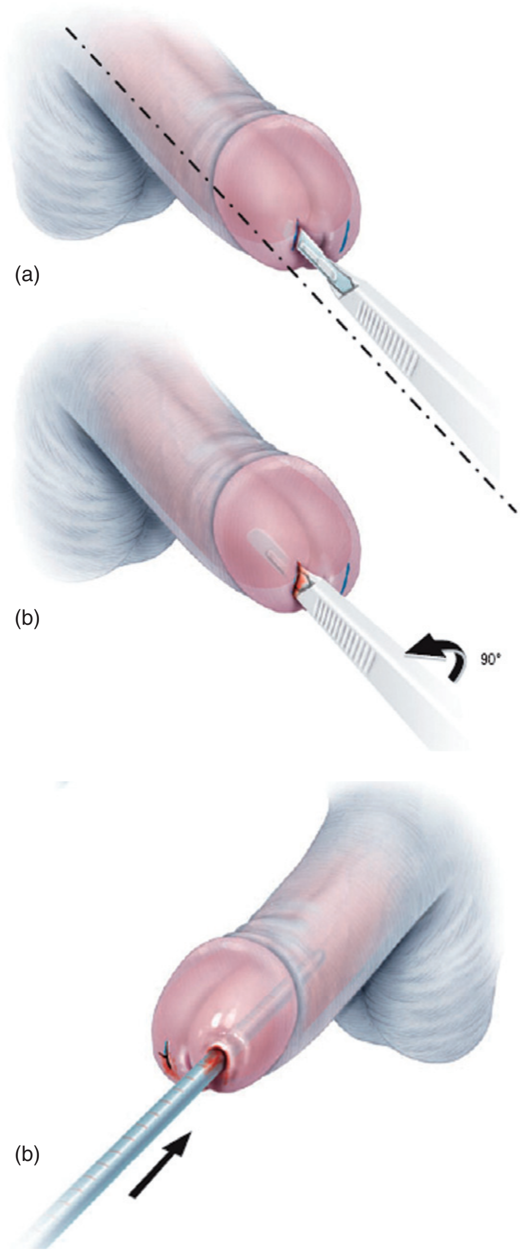

Figure 14.11 The T-shunt inserts a No 11 blade through the glans penis and rotates this 90° away from the urethral meatus. Failure to achieve detumescence leads to the surgeon attempting the same procedure on the opposite side. A size 8 dilator can be inserted through the corpora if detumescence is still not achieved. (Source: Garcia MM, Shindel AW, Lue TF. T-shunt with or without tunnelling for prolonged ischaemic priapism. BJUI 2008; 102(11): 1754–1764. Copyright Stephan Spitzer, www.medizillu.de)

Penile fracture

A penile fracture occurs when the penis is buckled during sexual intercourse, most commonly when the penis inadvertently impacts against the pubic bone or perineum. There are also cases of men forcibly snapping the penis during masturbation in order to produce rapid detumescence which is a practice called *taqaandan* in Northern Iran. Fracture of the penis occurs during buckling trauma to the penis. As the tunica albuginea of the corpora cavernosa is thick on the lateral aspects and thinner on the ventral and lower aspects, the injury occurs laterally as one corpus is “distracted” over the opposite corpus. Occasionally the tear will extend ventrally, and when it does it can injure the corpus spongiosum and/or the urethra. A concomitant urethral injury occurs in 20–30% of cases and should be suspected when blood appears at the urethral meatus. Once the diagnosis is made, urgent exploration and repair of the tunica albuginea is required.

Clinical features

A penile fracture is characterized by pain, swelling of the penile shaft, immediate detumescence and an audible “crack.” The significant swelling and ecchymosis is likened to an eggplant and is called the “aubergine sign.” If the hematoma is limited by Buck’s fascia the swelling is restricted to the penile shaft. However, expansion of the hematoma beyond Buck’s fascia leads to significant scrotal swelling which extends to the suprapubic area. Imaging the penis using ultrasonography (Figure 14.12) before surgical exploration can locate the site of the fracture so that the surgeon can modify the surgical approach in order to repair the fracture. Several approaches can be used including a circumcoronal incision followed by degloving of the penis. This approach will also require a circumcision to be performed. However, fractures that are located towards the base of the penis can be repaired by performing a penoscrotal incision in the midline raphe. This alternative approach avoids the need for a circumcision. If the fracture site is visualized and marked using ultrasonography then an incision directly over the fracture site can be performed.

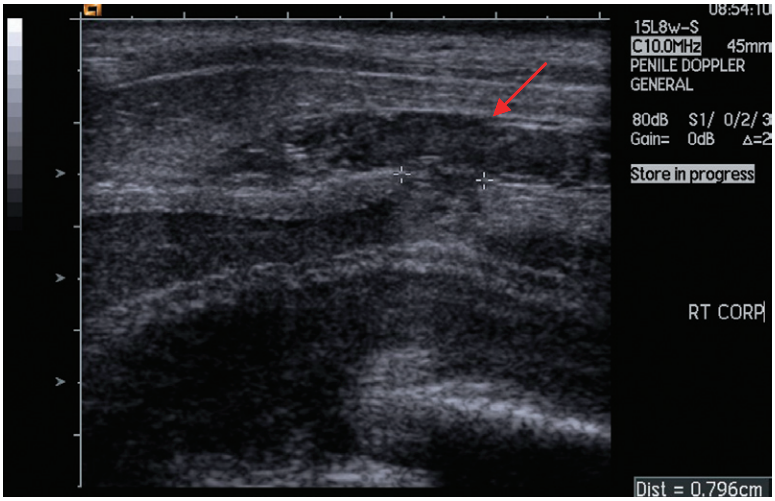

Figure 14.12 Penile fracture demonstrated using ultrasonography. The defect in the tunica albuginea is demonstrated (red arrow).

Surgical management

An urgent exploration of the penis followed by evacuation of the hematoma and repair of the defect using high tensile strength interrupted sutures (0 polydiaxanone) should be performed as soon as possible. A high index of suspicion for a urethral injury is required particularly if the patient reports hematuria or urethral bleeding. Either an on-table urethrogram or a flexible cystoscopy can be performed to visualize the extent of the urethral injury and the urethra can be repaired using 4-0 polyglactin sutures over a urethral catheter. Even with a delayed presentation of a penile fracture, surgical repair can be performed several days following the injury (Figures 14.13, 14.14, 14.15, 14.16 and 14.17). Urethral injuries should also be treated if present as shown below.

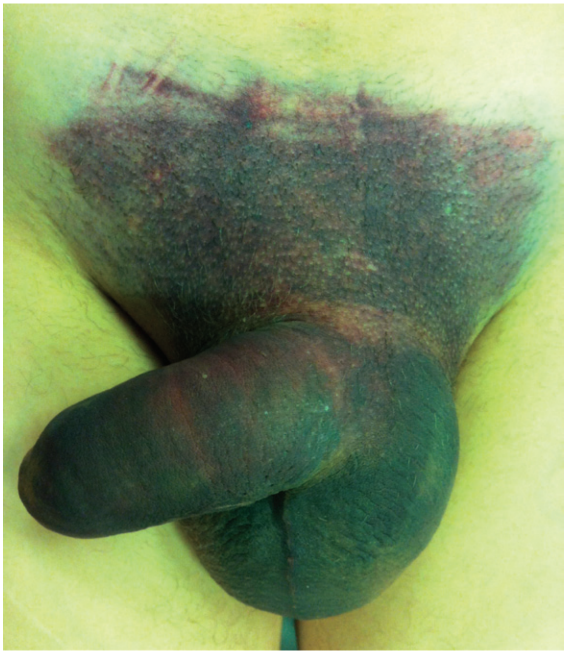

Figure 14.13 Extensive hematoma and bruising with a classic "aubergine sign." A flexible cystoscopy is performed at the start of the procedure to check for a urethral injury. If there is no urethral injury, a Foley catheter is inserted.

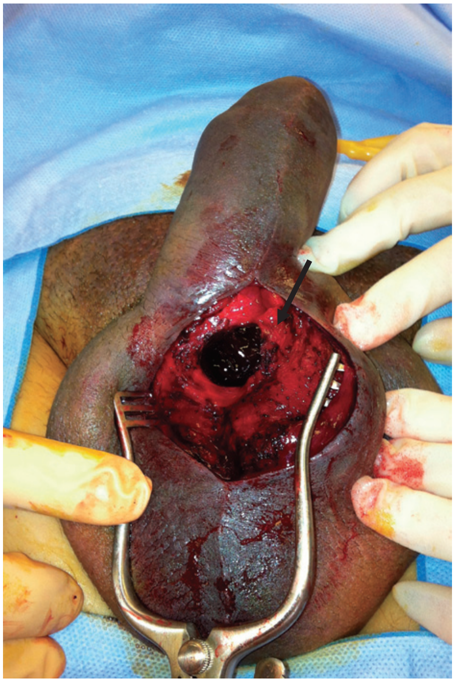

Figure 14.14 A midline raphe incision is used to explore the penis. The tear in the tunica albuginea (arrow) with an overlying hematoma is shown.

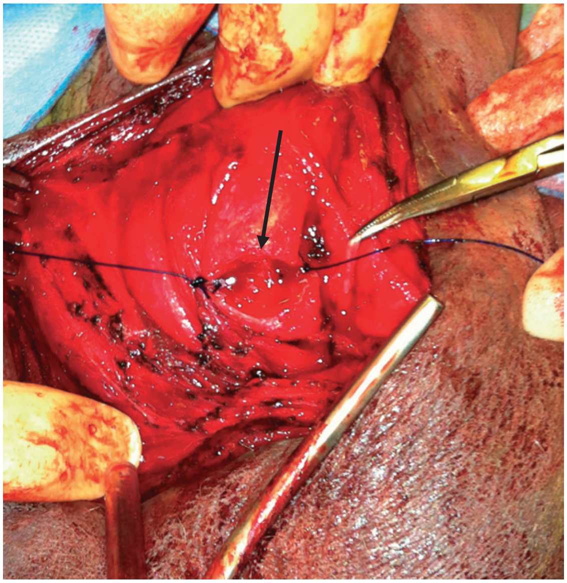

Figure 14.15 The hematoma is evacuated and the underlying smooth muscle in the corpus cavernosum is demonstrated (arrow). Two stay sutures are inserted at the edge of the fracture site.

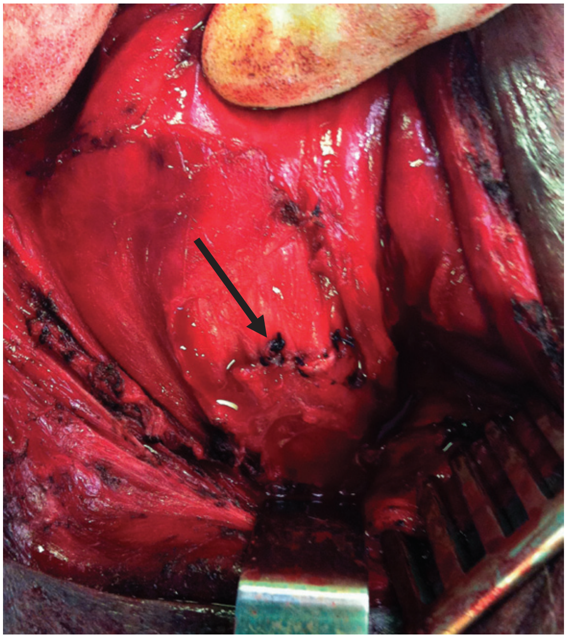

Figure 14.16 Interrupted 0 polydiaxanone sutures are used to suture the defect in the tunica albuginea. The suture knots are buried (arrow). A layered closure of the dartos and skin is performed with 3-0 polyglactin sutures.

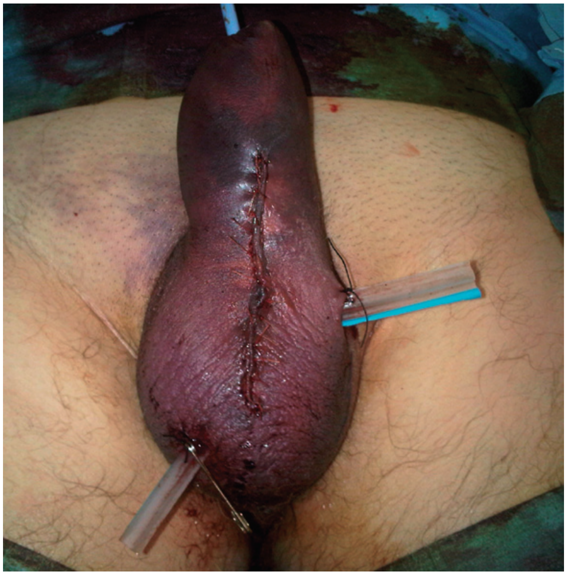

Figure 14.17 Corrugated drains are inserted at the end of the procedure. Patients can be commenced on a PDE-5 inhibitor when comfortable postoperatively. A pericatheter urethrogram is performed following a urethral injury prior to removal of the catheter. Sexual activity is avoided for 6 weeks.

Surgical outcomes

The aim of early surgical repair is to maintain normal erectile function and prevent the development of a penile curvature. In cases where a surgical exploration has not been performed, patients are at risk of penile curvature and erectile dysfunction. The late complication rates following surgical exploration and repair are in the region of 10%. However, in cases where a conservative approach has been adopted, complication rates are over 50%.

Urethral injury

Anterior urethral injuries can result from penetrating trauma (e.g. gunshots, explosions), blunt trauma (e.g. straddle injury), iatrogenic (e.g. during catheterization or endoscopic surgery), self-inflicted (e.g. foreign body insertion) and can also be associated with a penile fracture. Partial rupture of the urethra can be diagnosed using urethrography, and is sometimes managed conservatively with a suprapubic catheter followed by delayed repair if a stricture develops. However, complete rupture requires urgent exploration and reanastomosis.

Clinical features

Penetrating injuries to the urethra are commonly associated with other injuries such as penile skin loss, cavernosal smooth muscle destruction and scrotal trauma. Blunt injuries are characterized by a difficulty in voiding and urethral bleeding. Diagnosis is made by performing a urethrogram which locates the site and extent of the injury.

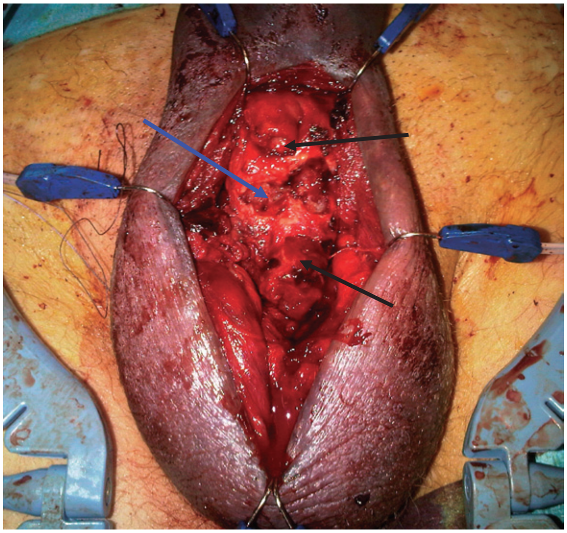

Figure 14.18 Complete rupture of the urethra (black arrows) following a penile fracture (blue arrow). A penoscrotal approach is used and this allows good exposure of the urethra and the flexibility to extend the incision.

Surgical management

In traumatic cases where a complete urethral rupture has occurred, urgent exploration and a tension-free urethral anastomosis must be performed. A urethral catheter is always inserted and a pericatheter urethrogram can be performed after 2 weeks to ensure that the anastomosis has healed (Figures 14.18 and 14.19).

Surgical outcomes

Early exploration and anastomosis of the urethra is associated with fewer late complications. A delay in the diagnosis results in a urethral stricture.

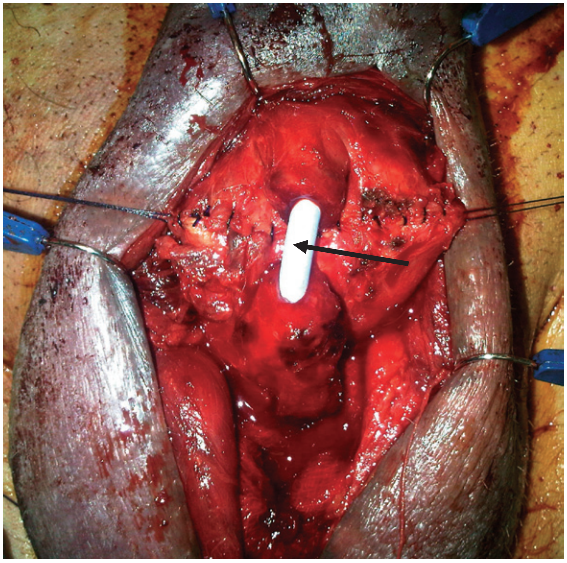

Figure 14.19 A catheter (black arrow) has been inserted following repair of the tunica albuginea using 0 polydiaxanone sutures. The two ends of the urethra are mobilized. The urethra is then repaired using 4-0 polyglactin interrupted sutures. A urethral catheter is kept in place for 2 weeks. A pericatheter urethrogram can be performed before removing the catheter to ensure that the anastomosis has healed.

Testicular rupture

Testicular rupture follows significant blunt trauma to the scrotum, resulting in rupture of the tunica albuginea, extrusion of the seminiferous tubules and hematocele formation.

Clinical features

Testicular rupture is associated with significant pain and swelling of the hemi-scrotum. It may be difficult to differentiate a testicular rupture from a scrotal hematoma (within the dartos layer) or an intratesticular hematoma without rupture of the tunica albuginea. An ultrasound scan of the scrotum can image the testicle and detect a rupture of the tunica albuginea, which requires urgent exploration and repair (Figure 14.20).

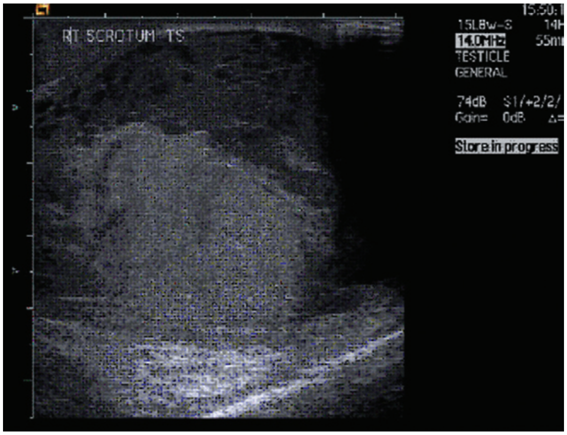

Figure 14.20 Scrotal ultrasound demonstrating the defect in the tunica albuginea and overlying hematoma following blunt trauma to the testicle.

Surgical management

Urgent scrotal exploration and debridement of nonviable seminiferous tubules followed by closure of the defect in the tunica albuginea is required in order to preserve testicular volume and function (Figures 14.21, 14.22, 14.23 and 14.24).

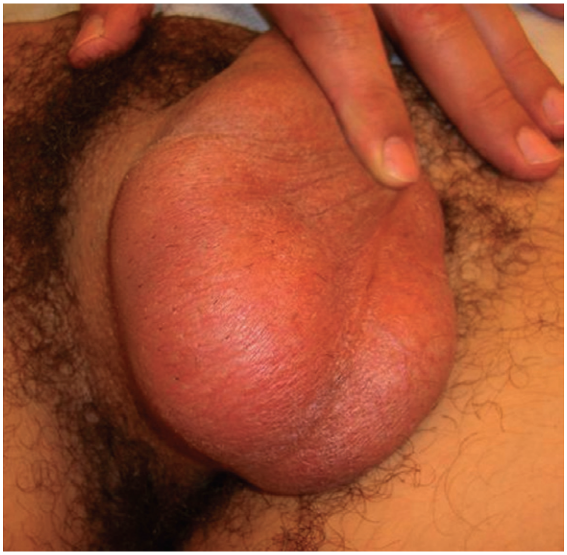

Figure 14.21 Swelling of the right hemi-scrotum following blunt trauma. Palpation of the testicle can be difficult because of the overlying hematoma or hematocele.

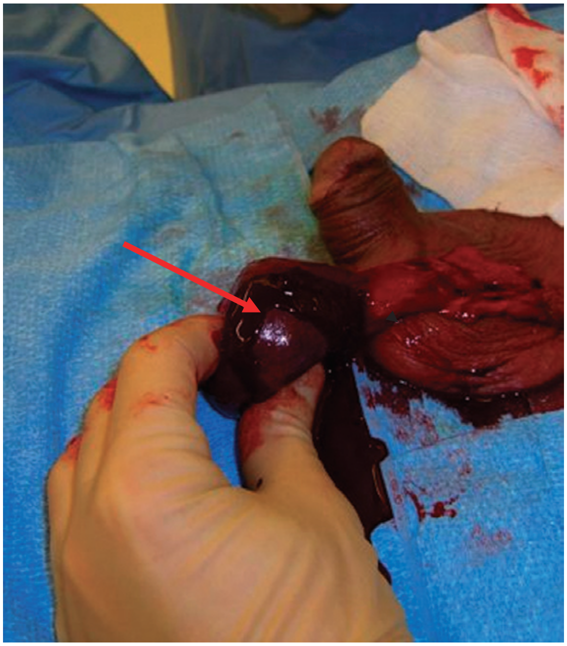

Figure 14.22 Exploration of the testicle is performed though a midline raphe incision. The hematoma is drained (red arrow). Rupture of the tunica albuginea with extrusion of the seminiferous tubules is shown.

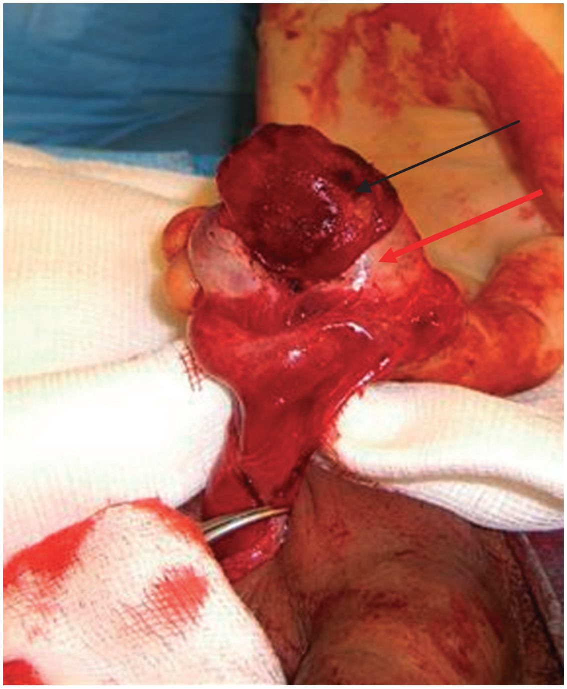

Figure 14.23 The nonviable seminiferous tubules are debrided. If the remainder of the testicle is viable then the tunica albuginea (red arrow) can be sutured directly using 3-0 or 4-0 polyglactin sutures. If required, a pedicled tunica vaginalis patch can be used to reconstruct areas where the tunica albuginea is deficient or to reinforce the closure. This helps to maintain the shape of the testicle.

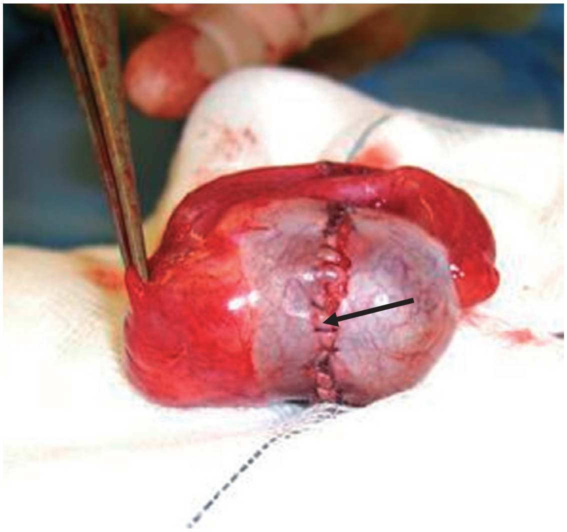

Figure 14.24 The tunica albuginea is closed using 4-0 polyglactin sutures (black arrow). A corrugated drain is inserted at the end of the procedure.

Fournier's gangrene

Fournier's gangrene is a necrotizing fasciitis of the external genitalia and perineum as a result of infection with synergistic aerobic and anerobic bacteria together with the development of endarteritis of the tissues. The common pathogens involved are streptococcal and staphylococcal species, enterobacteria, anaerobes and fungi. Cases of Fournier's gangrene are highest in diabetics, alcoholics or immunosuppressed patients. The mortality rate is in the order of 50% if treatment is not instituted early.

Clinical features

Initial signs may be subtle such as mild erythema and edema of the skin. However, as the infection spreads, skin blistering, necrosis, crepitus and systemic sepsis rapidly develops. Infection spreads along the fascial planes with fat necrosis and small vessel thrombosis a hallmark of the disease. Prompt and aggressive treatment is required with resuscitation, broad spectrum antibiotics and surgical debridement of nonviable tissue. Once the patient recovers from the acute event, genital reconstruction using a combination of skin grafts and flaps is commonly required.

Surgical management

As soon as the diagnosis is made and the patient is resuscitated, surgical debridement of necrotic tissue is required as soon as possible. Imaging and endoscopic examination of the urethra, bladder and lower gastrointestinal tract helps to locate a possible source of the infection. Parenteral antibiotics, oxygen and fluid resuscitation is required preoperatively and postoperatively, with patients normally requiring intensive care monitoring because of cardiorespiratory decompensation due to the overwhelming sepsis. The debridement of tissue should continue until the tissue is bleeding. Following initial debridement, further surgery is performed after 24 hours in order to remove any further necrotic tissue (Figures 14.25, 14.26 and 14.27).

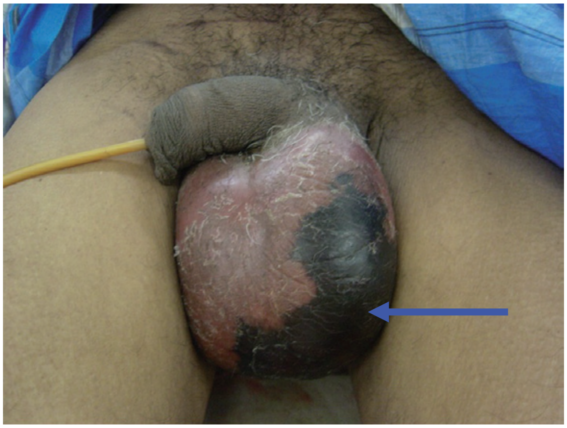

Figure 14.25 Area of necrosis (blue arrow) is visible on the scrotum with edema and erythema of the overlying skin.

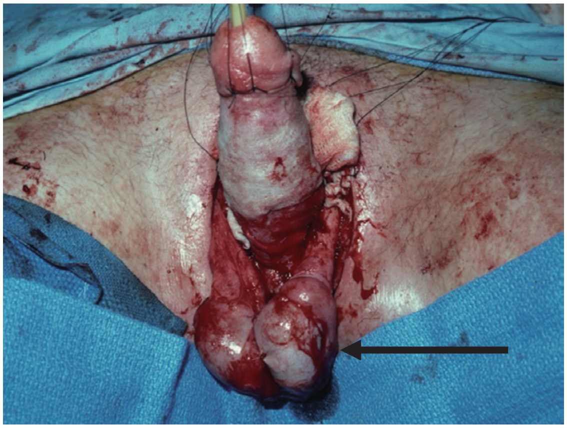

Figure 14.26 The necrotic tissue is debrided until healthy vascularized tissue is exposed. All tissue that is easily removed with blunt dissection should be considered involved. The testicles have been sutured together as this allows scrotal reconstruction to be performed at a later date. (Courtesy of Professor Jack McAninch.)

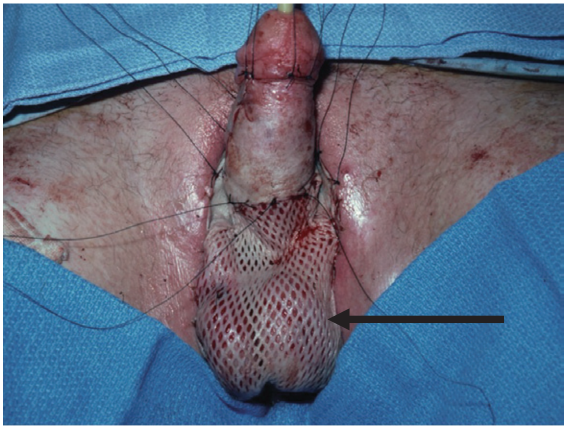

Figure 14.27 Once granulation tissue has formed over the testicles a meshed split thickness skin graft (STSG) is used to reconstruct the scrotum. (Courtesy of Professor Jack McAninch.)

Surgical outcomes

The mortality rate is high, with published figures between 50% and 75%. A number of parameters have been used to define the severity of the infection. The Fournier Gangrene Severity Index (FGSI) is based on the following clinical parameters:

- Temperature;
- Heart rate;
- Respiratory rate;
- White blood cell count;
- Hematocrit;
- Serum sodium;
- Serum potassium;
- Serum creatinine; and
- Serum bicarbonate.

Each parameter is given a score of 0–4 depending on the deviation from normal. A total score of more than 9 is associated with a higher mortality rate.

Traumatic amputation of the genitalia

Traumatic amputation of the genitalia can result from accidental injuries or self-harm, particularly in psychiatric patients. Penile necrosis can also occur following the use of constriction rings and electrical injuries.

Clinical features

Amputation of the penile shaft at various levels normally occurs in psychiatric patients or following domestic violence. However, bilateral testicular and penile amputation can also present as an emergency following industrial accidents or injuries sustained in warfare.

Surgical management

When faced with a case of genital amputation every effort should be made to recover the amputated parts which should be placed in slush (crushed ice). The patient should be fully resuscitated and broad spectrum antibiotics administered. The patient should then undergo urgent microsurgical reconstruction. Nonviable tissues are debrided and a washout performed to remove any foreign debris. In penile amputation the urethra is anastomosed first followed by suturing of the corpora cavernosa. A microsurgical reconstruction of the deep dorsal vein, dorsal artery and dorsal nerves of the penis is then carried out. If successful the glans remains perfused and warm. However, postoperatively there is inevitably some skin loss from the penile shaft skin but this can be covered using a split skin graft during a later procedure. (Figures 14.28a,b, 14.29, 14.30, 14.31, 14.32, 14.33, 14.34, 14.35 and 14.36).

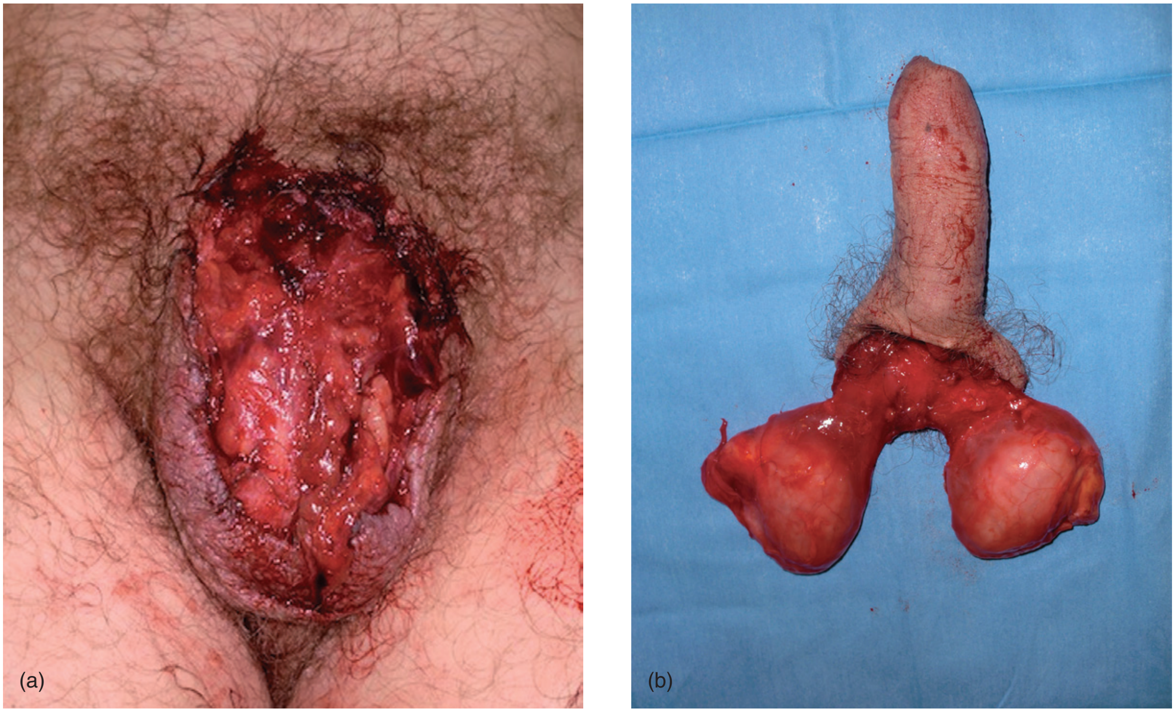

Figure 14.28 (a) and (b) A case of amputation of the penis and both testicles en bloc.

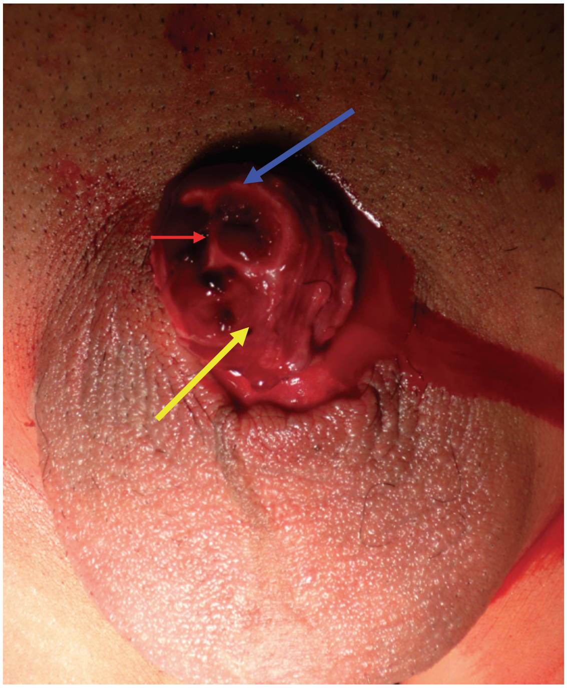

Figure 14.29 Patient presenting with a complete transection of the penile shaft. The midline septum is marked (red arrow). The urethra (yellow arrow) and left corpus cavernosum (blue arrow) are marked.

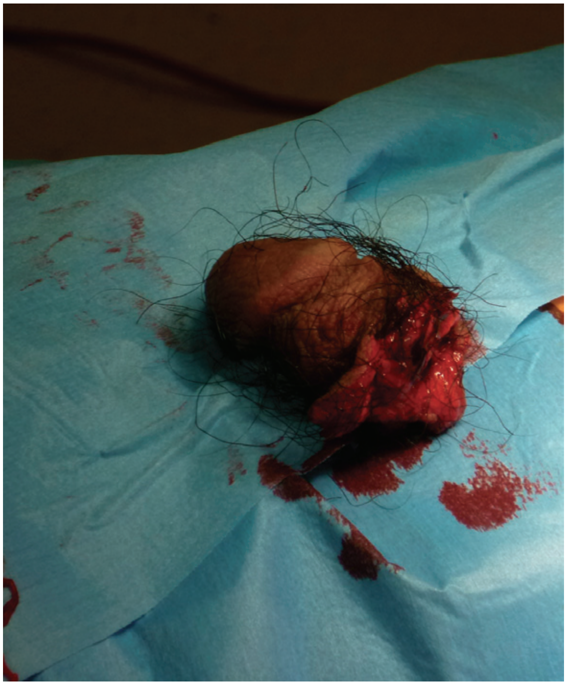

Figure 14.30 Distal penile shaft which has been kept in slush.

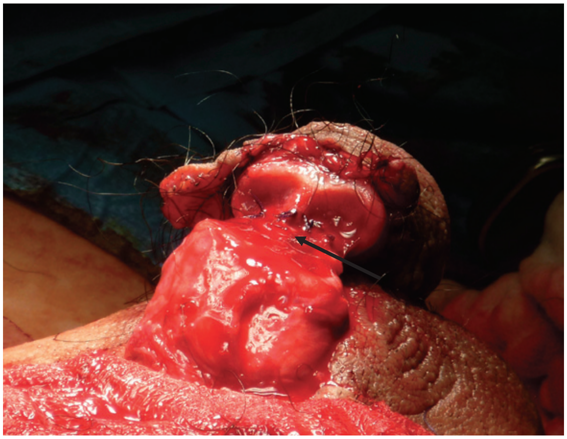

Figure 14.31 The urethra (black arrow) is anastomosed using 4-0 polyglactin sutures.

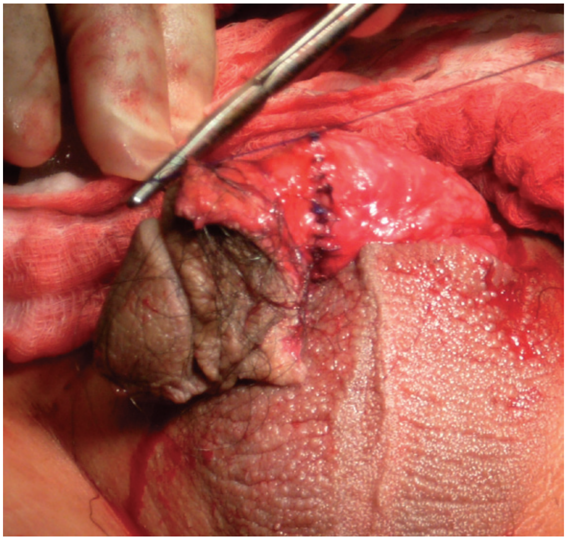

Figure 14.32 Following the repair of the urethra the tunica albuginea is sutured using 2-0 polydiaxanone or 0 polydiaxanone sutures.

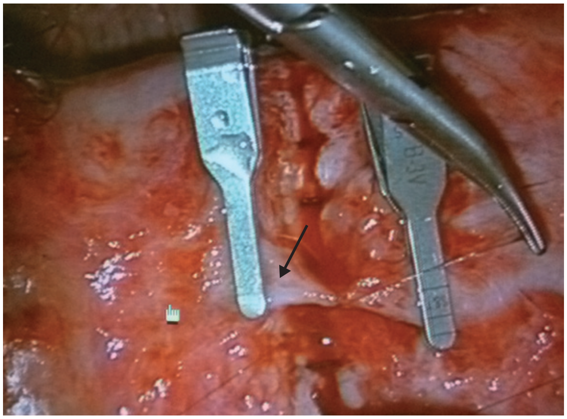

Figure 14.33 A microsurgical anastomosis of the deep dorsal vein (black arrow) is performed.

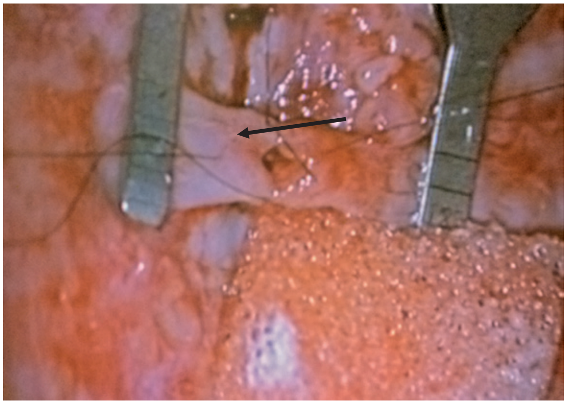

Figure 14.34 8-0 Nylon sutures are used to perform the vascular anastomosis. The venous anastomosis is followed by microsurgical anastomosis of the dorsal arteries and dorsal nerves of the penis.

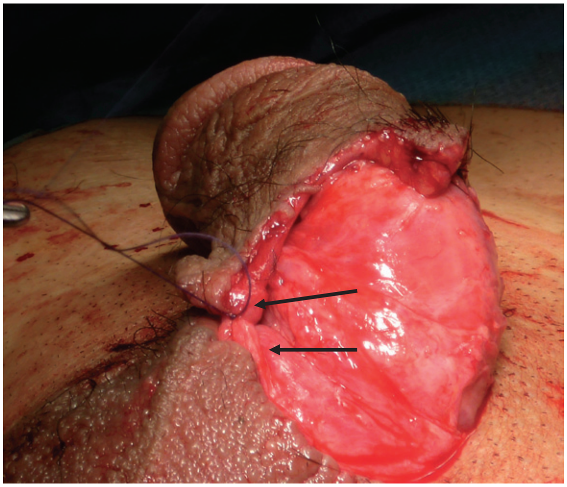

Figure 14.35 The dartos layer (black arrows) is sutured using 4-0 polyglactin sutures.

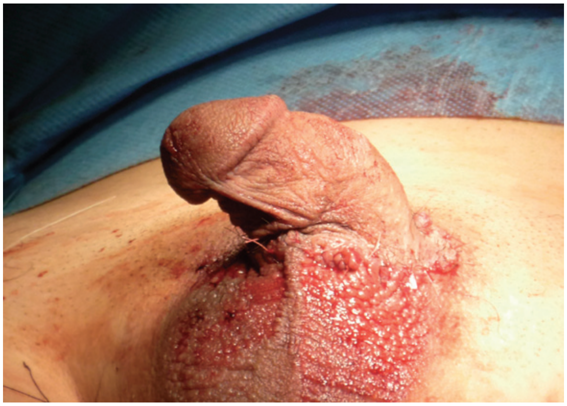

Figure 14.36 The penile shaft skin is sutured using 4-0 polyglactin.

Postoperative care

The penis should be kept elevated and Doppler studies performed on a regular basis to ensure that the vascular anastomosis is patent. In complete transections, where there are areas of penile skin loss, these can be debrided and a skin graft can be used to cover the defect once healthy granulation tissue has formed.

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